SUPREME COURT OF THE UNITED STATES.

OCTOBER TERM, 1900.

No. 277.

UNITED STATES REPAIR AND GUARANTY COMPANY, PETITIONER,

vs.

ASSYRIAN ASPHALT COMPANY.

ON WRIT OF CERTIORARI TO THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE SEVENTH CIRCUIT.

CHICAGO:
THE GUNTHORP-WARREN PRINTING CO.,
58 Dearborn Street.
1900.

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CERTIFIED COPY OF THE RECORD UNDER SUBDIVISION 3 OF RULE 3, SUPREME COURT RULES.

TRANSCRIPT OF RECORD.

IN THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE SEVENTH CIRCUIT.

October Term, A. D. 1899.

United States Repair and Guaranty Company, Appellant,
vs.
Assyrian Asphalt Company, Appellee.

Appeal from the Circuit Court of the United States for the Northern District of Illinois, Northern Division.

Transcript of Record filed September 5, 1899. Printed Record (stamped) filed Nov. 18, 1899.

EDWARD M. HOLLOWAY,
Clerk U. S. Circuit Court of Appeals, Seventh Circuit.

1 Pleas in the Circuit Court of the United States for the Northern District of Illinois Northern Division in Chancery sitting at the United States Court room, in the City of Chicago, in said District and Division, before the Honorable Christian C. Kohlsaat, District Judge of the United States for the Northern District of Illinois, on Thursday, the twenty-seventh day of July, being one of the days of the Regular July Term of said Court, in the year of our Lord one thousand eight hundred and ninety-nine, and of our independence the one hundred and twenty-fourth year.

S. W. BURNHAM,
Clerk.

United States Repair and Guaranty Company,
vs.
Assyrian Asphalt Company and James P. Mallette.
} In Chancery. 24534

Be it remembered that on this day to-wit: the twelfth day of June, 1897, came the complainant in said entitled cause by its solicitors and filed in the clerk's office of said court a certain Bill of Complaint, which said Bill of Complaint is in the words and figures following to-wit:

3 IN THE CIRCUIT COURT OF THE UNITED STATES,

For the Northern District of Illinois.

In Chancery. No. 24534.

United States Repair & Guaranty Co.
vs.
Assyrian Asphalt Company and James P. Mallette.

BILL OF COMPLAINT.

Your Orator, United States Repair & Guaranty Company, a corporation organized and existing under and by virtue of the laws of the State of Illinois, a citizen of said State of Illinois, and having its principal place of business in the City of Chicago, in said state, brings this, its bill of complaint, against the Assyrian Asphalt Company, a corporation organized and doing business

under and by virtue of the laws of the State of Illinois, and having its principal place of business at Chicago, in said Northern Division of said Northern District of Illinois, and a citizen of said State of Illinois, and James P. Mallette, who, your ora-
4 tor is informed and believes, is a citizen of said State of Illinois, residing in said Northern Division of said Northern District of Illinois, and is sued herein both individually and as president of the said defendant corporation.

And thereupon your Orator complains and says that before the 8th day of March, 1893, Amos H. Perkins was the true, original and first inventor of certain new and useful Improvements in "Method of Repairing Asphalt Pavements," fully described and claimed in the Letters Patent hereinafter mentioned, and which improvements, thus patented, had not, before his invention and discovery thereof, been known or used by others in this country or described in any printed publication in this or any foreign country, and which had not, for more than two years prior to the date of his application for a patent therefor, as hereinafter mentioned, been in public use or on sale in this country.

Your Orator further shows unto your Honors that the said Amos H. Perkins being so, as aforesaid, the first and original inventor and discoverer of said improved "Method of Repairing Asphalt Pavements," made application in due form of law to the proper department of the Government of the United States for Letters Patent therefor, in accordance with the then existing Acts of Congress; and at or about the same time, by an instrument in writing, duly executed and delivered the said Perkins assigned to the Western Paving & Supply Co., of Chicago, in the County of Cook and State of Illinois, all his right, title and interest in and to said invention and in and to any Letters Patent that
5 might be issued therefor, in and by which instrument the Commissioner of Patents was requested to issue any Letters Patent which might thereafter be granted upon and pursuant to said application to the said Western Paving & Supply Co., according to the terms of said assignment; and thereupon, after due proceedings had, Letters Patent of the United States numbered 501,537, and bearing date the 18th day of July, 1893, were, in pursuance of law, duly granted and issued, under the seal of the Patent Office of the United States, signed by the Secretary of the Interior and countersigned by the Commissioner of Patents, and delivered to said Western Paving & Supply Co., as the assignee of the said Amos H. Perkins, for the said improved "Method of Repairing Asphalt Pavements," whereby there was granted and

secured to the said Western Paving & Supply Co., and to its successors and assigns, for the term of seventeen (17) years from and after the date of said Letters Patent, the sole and exclusive right and liberty of making, using and vending to others to be used the said invention set forth in said Letters Patent, as will more fully appear by said Letters Patent, or a duly authenticated copy thereof, in Court to be produced and to your Honors exhibited, an uncertified copy of the specifications, claims and drawings of the said patent being hereto attached and made a part of this bill of complaint and marked "Exhibit A."

And your Orator further shows that, after the issuance of said Letters Patent No. 501,537, your Orator became, and now is, by virtue of a certain mesne assignment, the sole and exclusive owner of all legal and equitable title, of every name and
6 nature, in, to and under the aforesaid Letters Patent, including all rights of recovery of damages, savings, profits and license fees, for any and all infringements of the said Letters Patent had any time subsequent to the issuance thereof, as by said mesne assignment, or a duly authenticated copy thereof, here in court to be produced, will more fully and at large appear.

And thereupon your Orator further complains and says that, before the 30th day of July, 1894, Amos H. Perkins was the true, original and first inventor of certain new and useful "Improvements in Apparatus for Repairing Asphalt Pavements," fully described and claimed in the Letters Patent hereinafter mentioned, and which improvements, thus patented, had not, before his invention and discovery thereof, been known or used by others in this country, or described in any printed publication in this or any foreign country, and which had not, for more than two years prior to the date of his application for a patent therefore, as hereinafter mentioned, been in public use or on sale in this country.

And thereupon your Orator further complains and says that before the 15th day of June, 1895, Amos H. Perkins was the true, original and first inventor of certain other useful "Improvements in Apparatus for Repairing Asphalt Pavements," fully described and claimed in the Letters Patent hereinafter mentioned, and which improvements, thus patented, had not, before his invention and discovery thereof, been known or used by others in this country, or described in any printed publication in this or any foreign country, and which had not, for more than two years prior to the date of this application for a patent therefor, as
7 hereinafter mentioned, been in public use or on sale in this country.

And your Orator further shows unto your Honors that the

said Amos H. Perkins, being so, as aforesaid, the first and original inventor of said "Improvements in Apparatus for Repairing Asphalt Pavements," made application in due form of law to the proper department of the Government of the United States for Letters Patent therefor, on July 30th, 1894, and June 15th, 1895, respectively, in accordance with the then existing Acts of Congress and, at or about the same times, the said Amos H. Perkins did assign the right, title and interest in, to and under the said applications and any Letters Patent which might thereafter issue upon said applications, to your Orator, the United States Repair & Guaranty Company, by certain instruments in writing, duly executed and delivered by the said Amos H. Perkins, in and by which said instruments, the Commissioner of Patents was requested to issue any Letters Patent which might thereafter be granted upon and pursuant to said applications to the said United States Repair & Guaranty Company, according to the terms of said assignments and thereupon, after due proceedings had, Letters Patent of the United States No. 542,349 and No. 560,599, bearing date the 9th day of July, 1895, and the 19th day of May, 1896, respectively, were, in pursuance of law, duly granted and issued, under the seal of the Patent Office of the United States, signed by the Secretary of the Interior, and countersigned by the Commissioner of Patents, and delivered to the said United States Repair & Guaranty Company, as the assignee of the said Amos H. Perkins, for said improvements, as described in the applica-
8 tions aforesaid, whereby there was granted and secured to your Orator, the United States Repair & Guaranty Company, its successors and assigns, for the term of seventeen (17) years from the dates of said Letters Patent, respectively, the full and exclusive right and liberty of making, using and vending to others to be used, the said improvements and inventions set forth in said Letters Patent, as will more fully appear by said Letters Patent, or duly authenticated copies thereof, in court to be produced and to your Honors exhibited, uncertified copies of the specifications, claims and drawings of the said patents being hereto attached and made a part of this bill of complaint and marked "Exhibit B" and "Exhibit C."

And your Orator further shows that, by virtue of the premises, your Orator became and now is entitled to all the rights and privileges granted and secured, by said Letters Patents, and is now the sole and exclusive owner of all legal and equitable title of every name and nature in, to and under the aforesaid Letters Patent No. 542,349 and No. 560,599, including all rights of recovery

of damages, savings, profits and license fees for any and all infringements of the said Letters Patent had any time subsequent to the issuance thereof, respectively, as will more fully appear by said assignments, or duly authenticated copies thereof, in court to be produced.

Your Orator further shows unto your Honors that each of the inventions described and claimed in said three Letters Patent, respectively, is capable of being used conjointly with every
9 other invention described and claimed in said three Letters Patent, respectively, in the art of repairing asphalt pavements; and that the defendants have practiced, and are now practicing, the method disclosed in said Letters Patent No. 501,537, and in so doing have made and used, and are now making and using apparatus which embodies, in whole or in part, the inventions described and claimed in said Letters Patent No. 542,349 and No. 560,599.

And your Orator further shows unto your Honors that it has brought the aforesaid inventions into widespread public use in a great many cities and towns throughout the United States, and that the development of said inventions and the introduction thereof into public use has necessitated the expenditure of large sums of money, which have been spent in this behalf by your Orator; that the said patented inventions are, and have been proven, of great value and of great benefit to the public and profit to your Orator; and that the exclusive rights therein of your Orator have been generally recognized and acquiesced in by the trade and by the public at large, and, as your Orator is informed and believes your Orator has continued to be, and now is, in the exclusive possession of such rights secured in and by said Letters Patent, as aforesaid, except for the unlawful, illegal and injurious disregard and infringement thereof by the said defendant.

And your Orator further shows unto your Honors that said defendants, Assyrian Asphalt Company and James P. Mallette, and each of them, have been duly notified by your Orator of the existence of said Letters Patent No. 501,537, No. 542,349
10 and No. 560,599 and of your Orator's aforesaid title therein, thereto and thereunder.

And your Orator further shows, upon information and belief, that, well knowing the premises and the rights secured to your Orator, as aforesaid, contriving to injure your Orator and to deprive it of the benefit and advantages which might, and otherwise would, accrue to it from said inventions and discoveries, at divers times and occasions prior to the time of filing this, your

Orator's Bill of Complaint, and since the granting and delivery of the Letters Patent aforesaid, and since your Orator's rights in the premises were acquired, as aforesaid, wholly without the license or allowance, and against the will of your Orator and in violation of its rights secured by the aforesaid Letters Patent No. 501,537, No. 542,349 and No. 560,599, and in infringement of the aforesaid Letters Patent No. 501,537, No. 542,349 and No. 560,599, the said defendants James P. Mallette and Assyrian Asphalt Company, under the immediate supervision, direction and control of the defendant, James P. Mallette, as President, have at and within said Northern District of Illinois, and elsewhere, unlawfully, wrongfully and in defiance of the rights of your Orator, practiced and employed the method of repairing asphalt pavements described and claimed in said Letters Patent No. 501,537 and made and constructed, or caused to be made and constructed, for use, and used, and are now making, constructing and using numbers of apparatus for repairing asphalt pavements substantially like, and upon the plan and principle, and in imitation of, and embracing in each of said apparatus, either the whole or
11 one or more, of the said inventions or improvements contained in said Letters Patent No. 542,349 and No. 560,599 or substantial and material parts thereof. That is to say, the defendants have, at the time and place aforesaid, unlawfully and wrongfully and in defiance of the rights of your Orator, secured by said Letters Patent No. 501,537, No. 542,349 and No. 560,599, and in infringement of said Letters Patent, and wholly without your Orator's consent, made apparatus embracing the invention described and claimed in claim one of Letters Patent No. 542,349 and claims one, two, three, four and five of Letters Patent No. 560,599 or substantial and material parts thereof, and used the apparatus so constructed, or caused the same to be done, in practicing the method of repairing asphalt pavements described and claimed in claim one of Letters Patent No. 501,537; and they, the defendants, continue so to do and to cause by others to be used, the apparatus constructed in infringement of said Letters Patent No. 542,349 and No. 560,599 in practicing the method in infringement of patent No. 501,537, as aforesaid, and in violation and defiance of the rights secured to your Orator thereby as aforesaid, and to your Orator's great and irreparable loss and injury and by which your Orator has been, and still is being, deprived of great gains and profits, which it might, and otherwise would, have obtained, but which have been received and enjoyed and are being received and enjoyed, by the said defendants by and through their aforesaid unlawful acts and doings. And although

the said defendants have made and realized large profits, gains and advantages from the use of said inventions and discoveries, to what extent and how much they have been profited your
12 Orator does not know and prays a full and complete discovery thereof.

And your Orator further shows that the use of the aforesaid inventions and discoveries by the said defendants, and their preparation for and avowed determination to continue the same, and their other unlawful acts, encourage and induce others to infringe said Letters Patent in disregard of your Orator's rights and to its great loss and injury.

And inasmuch as your Orator can have no adequate relief, except in this Honorable Court, and to the end that the defendants may be compelled to account for and pay to your Orator the income, gains and profits thus unlawfully derived, or which might have been derived, from the violation of the rights of your Orator aforesaid, as well as the damages therefor, and be restrained from any violation of such rights, your Orator prays that your Honors may grant a writ of injunction perpetually restraining the defendants, said Assyrian Asphalt Company and James P. Mallette, both individually and as President, and each of them, their and each of their attorneys, solicitors, clerks, officers, employes, servants, agents, and workmen, and all claiming or holding through or under them from, in any and every form and manner, from making, using or selling any apparatus which shall in anywise consist, in whole or in part, of or embrace in any form or manner whatsoever the inventions in said Letters Patent No. 542,349 and No. 560,599 claimed; and from in any form and manner using, employing or practicing the process or method, and each and every part thereof, for repairing asphalt pavements which shall correspond, in whole or in part, to the process or method in said
13 Letters Patent No. 501,537 claimed; and that the use and sale of any apparatus made in accordance with your Orator's said Letters Patent No. 542,349 and 560,599 and embracing any part or feature claimed therein, that is now in possession of the defendants, or either of them, or their, and each of, their attorneys, solicitors, clerks, officers, employes, servants, agents or workmen, may be enjoined and that the same may be destroyed or delivered up to your Orator for that purpose.

And may it please your Honors to grant unto your Orator a writ of injunction conformable to the prayer of this Bill and also a writ of subpoena of the United States directed to the said defendants, said Assyrian Asphalt Company and James P. Mallette,

commanding them and each of them to appear and answer this Bill of Complaint, but not under oath (an answer under oath being hereby expressly waived), and to abide by and perform such orders and decrees in the premises as to the Court shall seem meet and be required by the principles of equity and good conscience.

And your Orator, as in duty bound, will ever pray, etc.

UNITED STATES REPAIR & GUARANTY COMPANY,
By VOLNEY W. FOSTER,
President.

RAYMOND & OMOHUNDRO,
Solicitors for Complainant.
JAMES H. RAYMOND,
Of Counsel.

State of Illinois, } ss.
County of Cook. }

Volney W. Foster, being duly sworn, deposes and says that he is the president of said United States Repair & Guaranty Company, complainant in the foregoing bill of complaint; that he has heard the said bill of complaint read and knows the contents thereof, and that the same is true, except as to such matters as are herein stated on information and belief, and as to them he believes them to be true; and that he verily believes that the said Amos H. Perkins was the original and first inventor of the improvements patented, as therein alleged, in and by United States Letters Patent No. 501,537, of July 18, 1893, No. 542,349 of July 9th, 1895, and No. 560,599 of May 19th, 1896.

VOLNEY W. FOSTER.

14 Subscribed and sworn to before me this 11th day of June, A. D. 1897.

WILLIAM O. BELT,
(Seal.) Notary Public.

(Endorsed) Filed June 12, 1897.

S. W. BURNHAM,
Clerk.

On the same day to-wit the twelfth day of June, 1897, a writ of Subpoena issued out of the clerk's office of said court directed to the Marshal of said District to execute, which said writ together with the Memorandum thereto attached and the Marshal's return thereon endorsed is in the words and figures following to-wit:

SUBPOENA.

United States of America,
Northern District of Illinois, } ss.
Northern Division.

The United States of America To Assyrian Asphalt Company and James P. Mallette, Greeting:

We command you and every of you that you appear before our judges of our Circuit Court of the United States of America for the Northern District of Illinois, at Chicago in the Northern Division of said District, on the first Monday in the month of July next, to answer the bill of complaint of United States Repair and Guaranty Company this day filed in the clerk's office of said court in said city of Chicago, then and there to receive and abide by such judgment and decree as shall then or thereafter be made, upon pain of judgment being pronounced against you by default.

To the Marshal of the Northern District of Illinois to execute.

Witness the Hon. Melville W. Fuller, Chief Justice of the United States of America, at Chicago aforesaid, this 12th day of June in the year of our Lord one thousand eight hundred and ninety-seven.

S. W. BURNHAM,
Clerk.

(Seal.)

15 MEMORANDUM.

The above named defendants are notified that unless they and each of them shall enter their appearance in the clerk's office of said court at Chicago aforesaid, on or before the day to which the above writ if returnable the complainant's bill will be taken against them as confessed and a decree entered accordingly.

S. W. BURNHAM,
Clerk.

MARSHAL'S RETURN.

I have served the within writ within my district in the following manner to-wit:

Upon the Assyrian Asphalt Company therein named on the 12th day of June A. D. 1897, by leaving a true copy of the same with James P. Mallette, President of the said company. Upon James P. Mallette therein named on the 12th day of June A. D. 1897 by delivering a true copy of the same to him, personally.

J. W. ARNOLD,
U. S. Marshal.
By H. R. CLARK,
Deputy.

(Endorsed) Filed June 14, 1897.

S. W. BURNHAM,
Clerk.

Afterwards to-wit: on the fourteenth day of August, 1897, came the defendants in said entitled cause by their solicitors and filed in the clerk's office of said court their Answer, which said answer is in the words and figures following to-wit:

16 UNITED STATES CIRCUIT COURT.

Northern District of Illinois.

Northern Division.

U. S. Repair & Guaranty Company
vs.
Assyrian Asphalt Company, and James P. Mallette.
} In Chancery. No. 24,534.

ANSWER.

Filed Aug. 14th, 1897.

Joint Answer of the Assyrian Asphalt Company (a corporation), and James P. Mallette, Defendants, to the Bill of Complaint of U. S. Repair & Guaranty Company, Complainant.

These Defendants, now and at all times hereafter reserving unto themselves all and all manner of benefit or advantage by ex-

ception or otherwise, which can or may be had or taken to the manifold errors, uncertainties, insufficiencies and imperfections in said Bill of Complaint contained, for Answer to said Bill, or to so much and such parts thereof as these Defendants are advised, it is necessary for them to make unto, answer and say:

I. Defendants are not advised, save as stated by the Bill of Complaint, that the Complainant is a corporation duly organized and existing as alleged in said Bill; they therefore deny the allegation in that regard and leave the same to be proven as Complainant may be advised. Defendants further answering admit that said Assyrian Asphalt Company is a corporation duly organized and existing under the laws of the State of Illinois and having its principal place of business at Chicago in the northern judicial District of said State, and that said James P. Mallette, named as co-defendant is the President of said Assyrian Asphalt Company.

II. Upon information and belief Defendants admit that the letters patent sued on herein, viz: (A) No. 501,537, Method of Repairing Asphalt Pavements, July 18, 1893; (B) No. 542,349, Apparatus for Repairing Asphalt Pavements, July 9, 1895; (C) 560,599, Apparatus for Repairing Asphalt Pavements, May 19, 1896, were issued in due form on applications filed in that behalf by one Amos H. Perkins of Chicago, Illinois, alleging himself to be the first and original inventor of the subject-matter set forth and claimed respectively therein.

These defendants deny that said Perkins was in fact such
17 inventor, but on the contrary allege that in view of the then known state of the art no invention was requisite to produce said several supposed improvements at the time each of them respectively was by said Perkins first devised.

III. Upon information and belief respondents deny that said Perkins was the true, original and first inventor of the subject-matter in said pretended Letters Patent set forth; they deny that the alleged improvements disclosed therein constituted a new and useful invention within the meaning of the Patent Law at the time said improvements were first devised by said Perkins; they deny that said improvements or substantially the same were not known or used in this country or had not been patented or described in any printed publication in this or in any foreign country before the alleged invention thereof by said Perkins.

IV. Further answering, respondents say that, except as alleged by the Bill of Complaint, they have no knowledge of the several assignments, mesne or final, by which the interest in said alleged invention and Letters Patent were conveyed unto complainant; respondents do not admit that the exclusive right of

making, using and vending to others to be used the improvements set forth by said Letters Patent No. 501,537 is vested in the complainant; and accordingly respondents leave the complainant to prove the several allegations of the bill concerning the exclusive right and title in said complainant under the Letters Patent aforesaid as it may be advised.

V. Upon information and belief, respondents do not admit that the improvements and inventions patented as aforesaid have been in the exclusive possession and enjoyment of the complainant nor that the same are of great value and profit to said complainant; respondents do not admit that the alleged improvements have been extensively introduced in public use, nor that the same have been received with great favor by the public, or that the public generally has acquiesced in the alleged exclusive right of complainant under said Letters Patent, and respondents call for strict proof thereof.

VI. Defendants admit that said Assyrian Asphalt Company, under direction of said Mallette as president, is engaged from time to time in the business of repairing asphalt pavements, and in such business has occasion to follow well-known methods in making said repairs and to employ certain tools and appliance in and about the same. But defendants deny that said Mallette save as president of the defendant herein is engaged in such business and further deny upon information and belief, that the practices followed and the appliances used in repairing asphalt pavements or any of them do in any wise infringe upon exclusive rights lawfully secured by Letters Patent unto said complainant.

18 *VII. Upon information and belief, defndants allege that the pretended inventions respectively defined by the several Letters Patent and the claims thereof here in suit were—long prior to the supposed discovery or devising thereof by said Perkins—known to various other persons and were disclosed or described in various antecedent patents and printed publication at present unknown to these defendants, but which they are diligently seeking to identify and when discovered, crave leave by apt amendment at the foot of this answer or otherwise as the Court may direct, to set forth and specify in detail for further defense in the action, as by statute allowed.

VIII. Respondents deny that said complainant has any right to an account for damages, profits, gains, charges or costs, to be recovered from these respondents; they deny said complainant's right to any injunction, provisional or perpetual, and deny that said complainant is entitled to any other or further relief whatever against these respondents.

All of which matters and things these defendants are ready to aver and maintain and prove as this Honorable Court may direct; without this that any other matter, cause or thing in complainant's said bill of complaint contained, material or necessary for these respondents to make answer unto, and not herein and hereby well and sufficiently answered, confessed, traversed, avoided or denied, is true to the knowledge and belief of these respondents; wherefore these respondents humbly pray to be hence dismissed with their reasonable costs and charges in this behalf most wrongfully sustained.

ASSYRIAN ASPHALT COMPANY,
JAMES P. MALLETTE,
By PEIRCE & FISHER,
Solicitors for Defendants.

LEROY D. THOMAN,
Of Counsel.

*Note. Paragraph VII expunged by order of court September 11th, 1897.

(Endorsed) Filed Aug. 14, 1897.

S. W. BURNHAM,
Clerk.

19 Afterwards to-wit: on the ninth day of September, 1897, came the complainant by its solicitor and filed in the clerk's office of said court a certain Notice and Exception to answer, which said Notice and Exception are in words and figures following to-wit:

NOTICE AND EXCEPTION TO ANSWER.

IN THE CIRCUIT COURT OF THE UNITED STATES.

For the Northern District of Illinois.

Northern Division.

United States Repair and Guaranty Company, vs. Assyrian Asphalt Company et al.	In Equity. General No. 24,534

To Mr. Leroy D. Thoman, Solicitor for the defendants, Marquette Bldg., Chicago:

We hand you herewith a copy of our exception to paragraph VII of your answer in the above entitled cause together with a copy of an order of court which we shall ask to be entered pursuant thereto, and beg to notify you that the same will come on for hearing before his honor, William J. Allen holding said Circuit Court, at his chambers Saturday morning next, September 11th, 1897, at 9 o'clock A. M. The judge, at our suggestion, has made this appointment, our suggestion being that we desire the pleadings to be promptly settled.

Very respectfully,

RAYMOND & OMOHUNDRO,
Solicitors for Complainant.

J. H. RAYMOND,
Of Counsel.

Service accepted this 8th day of September, 1897.

LEROY D. THOMAN,
Solicitor for defendant.

IN THE CIRCUIT COURT OF THE UNITED STATES.

For the Northern District of Illinois.

Northern Division.

United States Repair & Guaranty Company, vs. Assyrian Asphalt Company et al. } In Equity. General No. 24534

EXCEPTION TO ANSWER.

For Insufficiency and Impertinence.

Exception taken by the above named complainant to the joint answer of the defendants for insufficiency and impertinence.

For that, whereas, in the first, second, third, fourth and fifth paragraphs of the complainant's bill of complaint, it is alleged in the usual form and words uniformly employed, in such bills of complaint, and not necessary here to be set out in extenso, that the said Amos H. Perkins "was the true, original and first inventor of certain new and useful 'Improvements in Method of Repairing Asphalt Pavements' and in 'Improvements in Apparatus for Repairing Asphalt Pavements'" the said defendants have not in and by their answer filed August 14th, 1897, according to the best of their knowledge, remembrance, information and belief, answered the said allegations in said bill of complaint contained but do, in and by paragraph VII of their said answer reply to the said allegations of said bill as follows to-wit:

"VII. Upon information and belief defendants allege that the pretended inventions respectively defined by the several letters patent and the claims thereof herein suit were—long prior to the supposed discovery or devising thereof by said Perkins—known to various other persons and were disclosed or described in various antecedent patents and printed publications, at present unknown to these defendants, but which they are diligently seeking to identify and when discovered, crave leave by apt amendment at the foot of this answer or otherwise as the court may direct, to set forth and specify in detail for further defense in the action as by statute allowed."

In which particular the said complainant is advised that the said answer of the defendants is evasive, impertinent and insufficient and that the said paragraph should be stricken from
21 the said answer; and the complainant prays that the said answer may be, by order of court, amended accordingly.

JAMES H. RAYMOND,
Solicitor and of Counsel for the Complainant.

Chicago, September 8th, 1897.

(Endorsed) Filed Sept. 9th, 1897.

S. W. BURNHAM,
Clerk.

Afterwards to-wit on the eleventh day of September, in the July term of said court, 1897, in the records of proceedings thereof in said entitled cause before the Hon. William J. Allen, District Judge, appear the following entries to-wit:

ORDER OF SEPTEMBER 11, 1897.

United States Repair and Guaranty Company,
vs.
Assyrian Asphalt Company et al. } 24534

Upon the coming on to be heard of the complainant's exception for insufficiency and impertinence to the seventh paragraph of the defendant's answer, and both parties having been heard. It is ordered:

First: That the said seventh paragraph of the said answer shall be, and the same is hereby expunged.

Second: That the said answer may stand as thus amended and

Third: That the complainant may file instanter a replication to said answer.

ORDER OF SEPTEMBER 11, 1897.

United States Repair and Guaranty Company,
vs.
Assyrian Asphalt Company et al. } 24534.

The parties being before the court upon the exceptions of the complainant to the VII Paragraph of defendants' answer, which Exceptions were sustained, upon the suggestion of the com-
22 plainant, both parties having been heard. It is Ordered that the complainant herein shall have to and including the 1st day of October, 1897, for adducing its proofs in chief, that the defendant shall have from the 2nd day of October until the 13th day of November, 1897, inclusive, in which to take their proofs in support of their joint answer; and that the complainant shall have from the 15th day of November until the 11th day of December, 1897, inclusive, in which to take its evidence in rebuttal.

(General Replication filed September 11, 1897.)

Afterwards to-wit on the fourteenth day of September, 1897, there was filed in the clerk's office of said court a certain Stipulation, which said Stipulation is in the words and figures following, to-wit:

STIPULATION.

IN THE CIRCUIT COURT OF THE UNITED STATES.

For the Northern District of Illinois.

Northern Division.

United States Repair & Guaranty Company,
vs.
Assyrian Asphalt Company et al.
} In Chancery. General No.

It is hereby stipulated and agreed by and between the parties hereto as follows:

That each of the parties may adduce evidence herein upon reasonable notice in writing before any notary public or other officer, authorized to administer oaths and all evidence so taken shall be used and considered the same as if taken in all respects in full compliance with the 67th Rule in Equity.

That each of the parties shall have the right to retain until the hearing all their respective exhibits introduced herein, subject to full and free examination by opposing counsel at all reasonable times.

That each party shall furnish to the other, without charge, full copies of all testimony taken herein as the same shall be adduced and copies of all drawings and similar documentary exhibits.

That the record herein on behalf of each party shall be printed as provided by the rules of this court, and the cost of pre-
23 paring such printed record, with exhibits, shall be taxable herein as costs in this case; provided, however, that such printed records shall in all respects comply with the rules of the Circuit Court of Appeals for the Seventh Circuit; that not less than fifty copies of each record shall be printed and that each party shall in their respective printed records embody copies of all their respective paper exhibits in the cause.

That Patent Office printed copies of the specifications and drawings of all United States Letters Patent and Blue Books of British Letters Patent may be used in evidence without certification, but subject to correction for errors, if any.

That copies of assignments of United States Letters Patent, duly certified to by the Patent Office, may be introduced in evidence with the same force and effect as if the originals thereof

were introduced and execution thereof duly proven, but subject to correction for errors, if any.

RAYMOND & OMOHUNDRO,
Solicitors for Complainants.
PEIRCE & FISHER,
Solicitors for Defendants.

Chicago, September 13th, 1897.

(Endorsed) Filed Sept. 14th, 1897.

S. W. BURNHAM,
Clerk.

25 IN THE CIRCUIT COURT OF THE UNITED STATES FOR THE NORTHERN DISTRICT OF ILLINOIS, NORTHERN DIVISION.

United States Repair & Guaranty Company
vs.
Assyrian Asphalt Company et al.
} Gen. No. 24,534.

COMPLAINANT'S PROOFS.

Testimony taken and evidence adduced on behalf of complainant, pursuant to the attached notice, before E. B. Sherman, Esq., one of the Masters in Chancery of said Court, beginning at 10 o'clock a. m., on Wednesday, September 15, 1897.

Present: Mr. O. R. Barnett, of Raymond & Omohundro, solicitors for complainant; Mr. James H. Pierce, of Pierce & Fisher, solicitors for defendants.

Thereupon it was stipulated by and between the solicitors for the respective parties hereto as follows:

STIPULATION.

It is agreed between counsel for the respective parties, that the Complainant company is a corporation duly organized and existing under the laws of the State of Illinois in keeping with the final certificate duly issued and dated October 20, A. D. 1893.

26 Also, that Complainant company is the owner of Perkins Letters Patent No. 501,537, for method of repairing asphalt

pavements, dated July 18, 1893, and issued unto the Western Paving and Supply Company, as grantee, by virtue of an assignment in writing from said Western Paving and Supply Co. unto said complainant, dated Jan. 1st, 1894, and then delivered and duly recorded as required by law, prior to the commencement of this suit. The assignment last referred to conveys unto said complainant "all claims and demands of whatever kind for royalties, damages and profits accrued or to accrue for each and every use of said improvement and inventions, or any or all of them."

Further proof respecting the above particulars is hereby waived.

Thereupon complainant's solicitor offers in evidence Patent Office printed copies of United States Letters Patent No. 501,537, issued July 18, 1893, to the Western Paving and Supply Company as assignee of Amos H. Perkins; No. 542,349, issued July 9, 1895, to United States Repair & Guaranty Company, as assignee of Amos H. Perkins; No. 560,599, issued May 19, 1896, to United States Repair & Guaranty Company as assignee of Amos H. Perkins, and the same are thereupon marked respectively Complainant's Exhibit "Perkins Method Patent," "Complainant's Exhibit Perkins Apparatus Patent No. 1," "Complainant's Exhibit Perkins Apparatus Patent No. 2."

27 Thereupon complainant's solicitor presented a certain stipulation duly signed by the solicitors for the respective parties hereto and duly entitled in this cause, which stipulation is in the words and figures following:

It is hereby stipulated and agreed by and between the parties hereto, and by their respective solicitors, that the following facts are admitted to be true and shall be, and shall be considered as, evidence in this cause as fully as if duly proven in any usual manner.

FIRST. That subsequent to the dates of the patents herein sued upon, and prior to the commencement of this suit, the Defendant, Assyrian Asphalt Company, has caused to be made for it and has used apparatus for repairing asphalt pavement; and that the drawing hereto attached, entitled in this case and marked "Complainant's Exhibit, Defendant's Device," is a correct drawing of so much and such parts of such apparatus as it purports to show.

SECOND. That the defendant, Assyrian Asphalt Company, subsequent to the date of Letters Patent No. 501,537, herein sued upon, and prior to the commencement of this suit, has used said apparatus and caused said apparatus to be used in the repairing

of asphalt pavements in the City of Chicago, Illinois, in the following manner:

(1.) The tank of said apparatus being supplied with any suitable oil, an initial pressure is created in said tank by the use of the air pump thereto attached, which pressure causes the oil in said tank to be discharged through the burners under the hood or shield of said apparatus, and, upon said oil being ignited
28 in said burners, a blast of flame is projected horizontally under said hood or shield, and in such manner as to heat a portion of the supply pipe leading from said tank to said burners.

(2.) Said apparatus is placed over the portion of the pavement to be repaired and said burners, having been so ignited, the portion of the pavement under the hood of said apparatus is exposed to the heat from the blast of flame from said burners until said portion of such pavement is sufficiently softened to the depth of one-half inch, or more.

(3.) Said apparatus being then removed from the portion of the pavement to be repaired, that part of the asphalt of the pavement which has been so softened is thereupon scraped out with rakes, hoes or suitable tools to the depth of a half inch or more.

(4.) After such softened material is so scraped away and removed, fresh asphalt composition in a heated state is filled into the depression or space so scraped out, and is thereupon leveled, smoothed and burnished with heated irons and the other usual tools for such purposes, so as to bring the new material in such repaired place to the same level and make such patched portion of the pavement continuous with the original pavement immediately surrounding and adjacent to such patch or repair.

RAYMOND & OMOHUNDRO,
Solicitors for Complainant.
PEIRCE & FISHER,
Solicitors for Defendants.

29 Whereupon MELVILLE E. DAYTON, a witness produced on behalf of complainat, being first duly sworn, testified as follows:

Q. 1. Please state your name, age, residence and occupation?
A. Melville E. Dayton; upwards of fifty years of age; occupation, expert mechanic.
Q. 2. Please state what education and experience you have had tending to qualify you to testify as an expert in patent causes?
Adjourned to 2 o'clock p. m.

2 o'clock p. m.

Met pursuant to adjournment.

A. I have, for more than twenty-five years last past been engaged in the analysis of mechanisms, the description and definition of inventions as solicitor of patents, and the comparison of mechanisms with each other and with the descriptions and claims of patents. For more than twenty years last past I have testified many times each year as an expert witness in patent suits and concerning mechanical constructions, their correspondence with or differences from other structures and their responsiveness or lack of responsiveness to the descriptions and claims of letters patent. For these labors I was prepared by a natural aptitude for mechanics, by a study of the science of mechanics, by learning the machnist's trade and by the study and practice of mechanical drawing.
Q. 3. Have you read and do you understand the drawings, specification and claims of Letters Patent of the United
30 States No. 501,537, 542,349, 560,599, being the Letters Patent herein sued upon?
A. I have and do.
Q. 4. Please state your understanding of the inventions set forth in the specification of Letters Patent No. 501,537 and claimed in the claim 1 thereof, and set forth in the specification and drawings of Letters Patent No. 542,349 and claimed in claim 1, thereof; and set forth in the specification and drawings of Letters Patent No. 560,599, and claimed in the five claims thereof. In your answer please take up these patents in their chronological order and state fully your reasons for any conclusions which may be stated by you.
A. The first of the three patents mentioned in the question, to wit, No. 501,537, relates to a method of repairing the surface

of asphalt pavements. Each of the remaining two patents, to wit, No. 542,349 and 560,599, relates to apparatus for carrying out the method set forth in the first of the three patents. The method patent No. 501,537, not only describes in words the method therein set forth and claimed, but it also illustrates an apparatus which may be employed in practicing the method referred to, although the patent (as it states) is not restricted to the use of this particular apparatus. Inasmuch as the operation of the apparatus may be taken to indicate what the descriptive part of the patent means in some particulars, and especially with respect to the application of heat to a pavement to be repaired, I will, at the outset, briefly describe the construction and action of such apparatus as it is shown and described in the drawings and specifications.

31 A tank for holding gasoline or inflammable oil is supported upon a pair of wheels in a horizontal position, and from one end of the tank projects a frame work that supports a low hood, say 1 to 3 feet wide and 3, 4 or 5 feet long, beneath which a flame or a number of flames are produced from the inflammable material contained in the tank, such material being supplied to the flames or to the burners by a suitable pipe or pipes and under pressure of air or gas in the fluid tank. From the end of the tank opposite the hood and burners project handles by which a person may move the apparatus about from place to place to bring the hood and flame over a spot in the pavement to be repaired and to shift it to enlarge the field of operation of the flames in case the defective spot in the pavement is larger than the hood. An air pump is connected to the tank by which a suitable pressure may be applied to the liquid to give the desired "blast" at the flames and a pressure gauge on the tank enables the operator to determine the pressure in the tank and to maintain it at the proper limit.

The particular feature in the action of this apparatus to which attention is called is the blast. It is also to be noticed in connection with this feature that the hood measurably confines the flames to the dimensions of the hood.

Now turning to the specifications of this patent 501,537, which is for "the method of repairing asphalt pavement," the object is stated in these words:

"My invention is designed to produce a method whereby the repairing of asphalt pavements may be quickly and cheaply accomplished and a neater appearing pavement be
32 attained after repairing than has heretofore been the case."

After describing the old method of repairing such pave-

ments, and pointing out the defects of such old method, the specification goes on to say:

"In practicing my invention, however, I subject the spot to be repaired and the surrounding edges to such a degree of heat that the surface asphalt, not only the exact spot to be repaired but the surrounding portion to a greater or less degree, is reduced to the soft pliable state in which it was originally laid. With a rake or other suitable instrument it is then agitated and mixed with enough new material to fill up the spot to be repaired. It is then subjected to the usual finishing operations of ironing and burnishing."

After a statement concerning apparatus that may be used and after a special description of the particular apparatus shown in the drawing, the specification repeats somewhat more at length the steps of the method, including reference to mixing new material with the old and softened material, and concludes with two claims, the first of which omits mention of the mixing of the old and new material, which step is specifically set forth in the second claim. The said first claim, being that here in suit and referred to in the question, reads as follows:

"1. The method of repairing asphalt pavements which consists in subjecting the spot to be repaired to heat, adding new material and smoothing and burnishing it, substantially as described."

In stating how the apparatus shown in the patent is em-
33 ployed, "in subjecting the spot to be repaired to heat," the specification (at line 70, page 1), says:

"As explained above, when it is desired to repair a spot the apparatus is moved adjacent thereto with the burners directly above the spot. These soon reduce the surface asphalt both at the spot and at the surrounding edges to a pliable state, the strong blast causing not only the immediate surface, but the particles deep down to be melted and yet not burned."

It appears from the specification that prior to the invention of this method, after cutting out the asphalt which forms the surface material of the pavement, at and around the spot to be repaired, tar or its equivalent was applied to the surface of the excavation in the old material and the new material was applied upon this tar and then smoothed and ironed in the usual way. The tar referred to was for the purpose of cementing the old to the new material and holding the patch in place, or, as the patent has it, "the tar acting as a solder to hold the new material in place."

The method here described and claimed dispenses with the use of tar or other "solder" or cement the old material being directly united to the new and forming therewith a continuous body practically as before the repair was made, or before the defect appeared.

The advantages of the new method are set forth in the patent in contrast to the defects of the former method in which the patch was secured to the pavement by the tar. Speaking (line 31, page 1) of the tar system of patching or repairing, the patent says:

"When completed, however, the line or joint between the
34 old hardened material and the new material has been plainly discernible, and more often there has been more or less of a ridge. Again this new block of material by reason of frost or from other causes is frequently torn loose from its soldered connection with the old material thus necessitating new repairs."

In the new method there is no tar employed between the old and the new material, but, after having heated the old material by the blast so as to reduce it to substantially the same soft or melted condition in which it was originally applied, the new material added forms an immediate and perfect union with the old material without the necessity for tar or any other interposed cement or "solder." This intimate union of the old and new materials takes place at all points of their contact, beneath as well as at the edges, makes the patch integral with the pavement and obviates all the faults in the old method.

In this connection it should be stated that while the patent makes no mention of the removal of any of the old material, in practice the surface of the old material, after being melted or softened, is taken off to a little depth, say half an inch to an inch, as found convenient. By doing this, the powdered cement which was applied to the original surface of the pavement when fresh, and any and all impurities and foreign substances which may have been pressed into the surface of the pavement in use, are removed and a fresh surface of asphalt composition is exposed for union with the new similar material added to fill the place level with the general pavement around it.

35 Patent No. 542,349 is exclusively for an improvement in apparatus of the general character illustrated and described in the method patent just above considered. In such former apparatus only the burners themselves were immediately exposed to the flames beneath the hood and the vaporization of the liquid fuel took place mainly or exclusively at or immediately adjacent

to the points of its emergence, or at the perforations through which it escaped to form the flames. In the patent 542,349 the pipe which supplies the burner is so arranged as to be directly exposed to the flames so that the liquid in the supply pipe is vaporized and a back pressure is thereby produced through the pipe in the supply tank. As a consequence, it became unnecessary to frequently pump air into the tank or reservoir to keep up the required pressure to give the blast. The air pump was, however, present in the apparatus and used to give the initial pressure in starting the operation, but, by reason of the back pressure resulting from the vaporization of the hydro-carbon liquid in the supply pipe, it became necessary to operate the air pump at short intervals.

The patent says:

> "The objects of my invention are to have the apparatus of such character that the heat of the burners may be utilized to produce and maintain pressure in the fuel tank, whereby a more uniform heat is produced. * * *"

The first claim (which is that in suit, and which pertains to this feature of the improvement) reads as follows:

> "In an apparatus for repairing asphalt pavements, the combination with a series of hooded fluid burners and a reservoir for supplying fuel thereto, said reservoir and burners being portably mounted, of a supply pipe connecting the
> 36 reservoir with the burners and exposed to the heat of the burners, substantially as described."

The manner in which the supply pipe is "exposed to the heat of the burners" is most clearly indicated in Fig. 3, of this patent, which shows the hood provided with a longitudinal slit or opening in its top of about the width of the large supply pipe, and the supply pipe placed in this slit so as to present its lower surface directly to the heat of the flames.

Patent No. 560,599, being the third patent in suit, sets forth several improvements in the same general kind of apparatus for repairing asphalt pavement. The object of the improvements here described and claimed will be learned from the following statement, beginning at line 17 of the specification, preceding which reference is made to patents No. 500,556 and 517,191 and might have been made to patent 542,349:

> "In said patents are shown blasts of flame or super-heated air directed vertically upon the pavement and under the hoods designed to confine the heat to the part of the pavement intended to be repaired. I have found by practice that while such an apparatus is thoroughly effective in accom-

plishing the desired result it is open to the objection that the heat, under the influence of the strong blast and winds, will escape around the edges of the hood, and thus soften more of the old pavement than is desired, thereby increasing the labor and cost of repair. This objection is particularly prominent when it is desired to repair narrow cracks in the pavement, and as the hood of these prior machines cannot rest directly upon the ground, so as to confine the heat to the limits thereof without smothering or objectionably reducing the flame-jets, this objection cannot be overcome in the class of machines in which hooded burners are employed. A further and more serious objection, developed by prac-
37 tice, is the burning out of the valves of the numerous burners necesarily employed, which even the shields can not effectively protect against the intense heat to which they are subjected, except for but a short time, and, furthermore, it is necessary with such burners to employ a high grade of gasoline or naphtha. The prime object of this invention is to overcome all of these objections by dispensing with all valved burners and by delivering the heat to the surface to be repaired by horizontal instead of vertical blasts.

Another object is to enable the confinement of the heat to the limits of the hood and thereby avoid the objection incident to the heating of the unworn pavement beyond the limit of the hood."

In this patent the hood is arranged to lie upon the pavement, along its edges, when in use, for the purpose of confining the flame more certainly to the limits of the hood. The hood is practically closed at its end adjacent to the reservoir, being provided with a vertical head having slits or holes of ample dimensions to admit the passage of the pipes and burners or flames from the burners and to supply air to the flames within the hood. At the opposite end the hood is open. The supply pipe leads into the hood and is extended therein by means of a coil or coils, to expose ample extent of the pipe to insure vaporization of the hydro-carbon liquid before it reaches the burners, so that the vapor alone is emitted to the flames. The burners are mere orifices or nozzles without valves, so that they will not clog or become obstructed, and the use of such open nozzles is facilitated by the provision of the vaporizing coils referred to and the emission of vapor only at the burners. The supply of liquid to the coil is in this, as in the former construction, controlled by a suitable valve in the supply pipe between the hood and reservoir.

The burner nozzles are arranged in a horizontal position so
38 as to send the flame lengthwise of the hood and horizontally over and along the surface to be treated. The burner nozzles may stand wholly without the hood and adjacent to its head (in front of the openings in the head) or they may project through openings in the head into the hood. The employment of valveless burners or nozzles in connection with the vaporizing coil leading to the burners, enables a cruder and cheaper quality of oil to be used with perfect success.

The claims are five in number, all involved in this suit, and read as follows:

"1. In an apparatus for repairing asphalt pavements, the combination with a hood, of one or more burners arranged to discharge horizontally into the hood, said hood being closed at the top, sides and one end thereof, and arranged to confine the heat to the limits of the same, substantially as described.

2. In an apparatus for repairing asphalt pavements, the combination with a hood open at one end thereof, of one or more burners arranged to discharge into the other end of said hood, said hood being arranged to confine the heat to the limits of the same, substantially as described.

3. In an apparatus for repairing asphalt pavements, the combination with a hood, closed at one end and open at the other and provided with one or more perforations in the closed end thereof, of one or more burners arranged to discharge into the hood through said perforations, said hood being arranged to confine the heat to the limits thereof, substantially as described.

4. In an apparatus for repairing asphalt pavements, the combination with a portably-mounted reservoir, a hood, and a supply-pipe leading from said reservoir and disposed underneath the hood, of one or more burners connected with said pipe and arranged to discharge horizontally into the hood, said hood being arranged to confine the heat to the limits thereof, substantially as described.

5. In an apparatus for repairing asphalt pavements, the
39 combination with a portably-mounted reservoir, a hood, closed at its top, sides, and one end thereof, and a supply-pipe leading from said reservoir underneath the hood and terminating at a point beyond one end of the hood, of one or more burners connected with said supply-pipe and ar-

ranged to discharge horizontally into the hood, substantially as described."

Adjourned to Thursday, September 16, 1897, at 10 o'clock a. m.

September 16, 1897.

Met pursuant to adjournment.

Present as before.

Direct examination of Melville E. Dayton continued.

A. (Answer continued.) The terms "arranged to confine the heat to the limits of the same" (to the limits of the hood), have reference to the feature of construction by which the hood, when lowered to the ground will come in contact along its lower edges, or practically so, with the surface of the pavement. In the prior machines it would appear that the lower edges of the hood when held horizontal would be a little above the surface of the pavement, or, when allowed to touch the pavement, it would do so only at its outer or more remote end and a considerable space would exist beneath its edges at other points. The hood is shown in the prior patent as having four depending sides and it would be a requisite, therefore, that the operator maintain his hold upon the handle and thereby sustain the hood a proper distance throughout its length above the pavement. Being "arranged" to drop upon the pavement and to touch or proximate it throughout the length of the hood, requires that one end of the hood be open and permits the operator to detach his hold, the machine being properly poised on its axle to allow the hood to drop to the ground.

The first two claims of patent, 560,599, are differentiated mainly with reference to the opening left in one side or end of the hood. In the first claim the hood is said specifically to be "closed at the top, sides and one end." In claim 2 the hood is said to be "open at one end thereof" without being said to be closed at the opposite end, as in the first claim. This is based on the statement in the patent found at line 110, et seq., of page 2, which provides for the possibility of leaving the hood open, under some circumstances, at the two opposite ends.

Claim 3 is differentiated from claim 1 by omitting to specify the horizontal direction of the discharge of the burners. Claim 4 is differentiated from claim 1 by making the disposition of the

supply pipe "underneath the hood" (the coil) a specific feature. Claim 5 involves the feature of carrying the supply pipe underneath the hood and then out of the hood where it is provided or connected with "one or more burners," here, as in claims 1 and 4, distinctly specified as "arranged to discharge horizontally into the hood."

Q. 5. Referring to the first part of your answer to question 4, please state whether, according to your understanding of Letters Patent No. 542,349 and 560,599, the apparatus therein described and claimed in claim 1 of the first of these patents and in the five claims of the second of them is necessarily limited, by the patents, to use in the practice of the method described and claimed in Letters Patent No. 501,537?

A. The remark made by me and referred to in the question, as I understand it, is as follows:

41 "Each of the remaining two patents No. 542,349 and 560,599, relates to apparatus for carrying out the method set forth in the first of the three patents."

I do not understand that the machine patents referred to are restricted to the use of the apparatus in the practice of the method described and claimed in Letters Patent No. 501,537, but that said machine patents cover said machines equally for all uses for which they are adapted, notwithstanding said machines appear to have been devised, primarily, for the practice of the previously devised method of repairing asphalt pavement.

Whereupon Complainant's solicitor offers in evidence a certain drawing marked "Complainant's Exhibit Defendants' Device", which is admitted to be the same drawing which is specified in the stipulation of facts between the parties hereto, which is set forth at length on pages 2 and 3 of the typewritten copy of this record.

Q. 6. Have you read the stipulation of facts between the parties hereto, which is set forth at length on pages 2 and 3 of the typewritten copy of this record, and have you examined the drawing marked "Complainant's Exhibit Defendants' Device," which is referred to in said stipulation, and do you understand the construction shown in said drawing and the method of using the apparatus so shown in the repair of asphalt pavement, as described in said stipulation?

A. I have and do.

Q. 7. Please compare the apparatus shown in "Complainant's Exhibit Defendants' Device" with the invention shown and described in the drawings and specification of Letters Patent No.

542,349, and particularly claimed in claim 1, thereof, and
42 also with the inventions described and shown in the specification and drawings of Letters Patent No. 560,599, and specifically claimed in the five claims thereof, pointing out in your answer wherein the construction of said defendants' device is the same as or differs from the inventions so described and claimed in said Letters Patent, and give in your answer fully your reasons for any conclusions which may be stated by you. In making this comparison you may, if you deem desirable, make on said drawing of defendants' device such marks or letters of identification as you may see fit.

A. I have applied to the drawing "Complainant's Exhibit Defendants' Device" the same letters of reference which are applied to the corresponding parts in the later machine patent No. 560,599, with which the more extended comparison of Defendants' device is required to be made under the question. Said drawing of Defendants' device contains three figures, Fig. 1 is a top or plan view with a part of the hood top broken away to show the disposition of the supply pipe within the hood. Fig. 2 is an end view of the hood looking at the closed end thereof, and Fig. 3 is a side elevation of the entire machine.

Placing this drawing of Defendants' device along side the drawing Fig. 1 of the patent in suit, No. 560,599, it is visually evident that the machines have a general correspondence. The reservoirs D and the hoods H of the two machines are substantially alike in their relation to each other and to the carrying wheels C, while the hoods are in both cases rigidly connected with the wheel-supported reservoir by the same extended bars A, which are bent alike in both cases to form the handle B. In
43 the patent the bars A extend back a distance above the hood H, and are connected with the latter by the rigid straps G, while in the Defendants' device said bars A are bent downward between the wheels and the hood so as to lie upon the hood and are connected with the latter by the bolts g. In the patent the supply pipe J emerges from the top of the reservoir D (though extending within the reservoir to near the bottom thereof) and thence passes rearwardly and downwardly to a point opposite the adjacent closed end of the hood through which it passes to form a coil beneath the hood, as best shown in Figs. 2 and 4 of the patent. In the drawing of defendants' device this supply pipe J emerges from the bottom of the reservoir D, and passes first latterly and thence rearwardly through the adjacent closed end of the hood to form the coil beneath the latter. In both cases alike

the supply pipe, after being extended and disposed suitably beneath and within the hood, projects at its end J' out from the hood through the closed end thereof, where it is laterally extended near the end of the hood, its lateral extension being provided with valveless "permanently open nozzles N," which are arranged to direct the flame jets horizontally into the hood towards the open end thereof and around the coil of the supply pipe. In the several figures of the patent drawing these nozzles N are shown wholly external to the hood and adjacent to openings in the closed end thereof, but the patent provides that they may extend beneath the hood and they are so shown in the drawing of Defendants' device. In both the patent and the drawing of Defendants' device the supply pipe is provided with a hand valve L for regulating the supply of oil to the coil and burners, and also with a further valve K, which the patent
44 says may desirably be a "cock valve" when gasolene or other light oils are employed, and may be a "non-return or check-valve" when heavier oils are employed. When the lighter oils are employed and K is a cock-valve, the back pressure produced by vaporization in the coil of the supply pipe beneath the hood, will maintain the pressure in the reservoir more or less perfectly, and obviate the necessity of entire reliance upon the air pump to keep up such pressure; but when heavier oils are employed for fuel, the patent says "I prefer to rely upon the artificial pressure obtained by means of the air pump, and substitute for the cock-valve K a non-return check valve, which will permit the flow of the oil under pressure from the tank to the burner, but will prevent the return thereof or of the gas generated in the pipes exposed to the heat of the burners."

In the drawings of the Defendants' device the reservoir B, is provided with a pressure gauge F, and is connected with an air pump E. In the drawing of the patent this air pump is permanently mounted on the reservoir or frame, and is connected by a rigid metal pipe with the valved pipe leading from the top of the reservoir, while in the drawing of Defendants' device the air pump is not mounted rigidly on the frame and is connected with the valved inlet to the reservoir by a flexible tube which I have marked E' In practice with the Defendants' device, the air pump will be placed on the ground as shown in Figs. 1 and 3, for operation, but when the machine is to be shifted about the air pump is laid upon the machine as I have indicated in dotted lines in Fig. 3. The tank in both cases is provided with a suitable inlet by which it may be filled.

The differences with reference to the frame connections
45 uniting the hood to the wheel-supported reservoir in the two machines and in the arrangement of the supply pipe between the reservoir and the hood are manifestly merely mechanical and wholly immaterial. The arrangement of the supply pipe J beneath and within the hood to form a circular coil, as shown in the drawing of Defendants' device, is also manifestly not an essential difference from the arrangement of said supply pipe as shown in Figs. 2, 4 and 5 of the drawing of the patent. There are, therefore, no essential differences between Defendants' device and the machine shown and described in Complainant's patent 560,599. As to the valve K, I am informed that in Defendants' machine it is actually a check-valve or non-return valve, which is one of the two forms of valve expressly provided for in this Complainant's patent 560,599. The differences with respect to the air pump are purely mechanical and have no relation whatever to the operation of the machine and, as the air pump is not a novel device in this patent 560,599, and is not dependent upon a rigid connection with the reservoir or machine frame for its operation, as contemplated in said patent, the Defendants' device here presents no essential difference from the device shown in the patent.

Defendants' device being in construction essentially the device of the patent 560,599, it has necessarily the same mode of operation and the same adaptation for use, whether in connection with asphalt pavement or otherwise. The specification of the patent reads as literally to the Defendants' device as it does to that shown in the patent. I quote from the specifications as applicable to Defendants' device, the following (line 61, p. 2):

"* * * jets of flame are delivered to the hood at the one end thereof and pass along under the hood out of the
46 forward open end thereof, thus serving to heat that portion of the pavement covered by the hood in its passage through the hood. To insure the heating of only so much of the pavement as is covered by the hood, the hood may be allowed to rest directly on the pavement, which can not be done with hoods wherein vertically disposed blasts are employed, and as the ground in conjunction with the hood, in point of fact constitutes a horizontal flue for the heat or flame jet, even though the hood does not snugly fit the surface of the ground, there will be a tendency to draw air in at the side edges of the hood rather than to expel the heat out from under the side edges. * * *

"The disposition of the supply pipe under the hood serves to convert the liquid fuel into a gas which [in the case when the valve K is not a check-valve, but is a cock-valve, as when lighter oils are used] backs up and stores pressure in the tank A, while at the same time supplying gas to the burners, and by employing the horizontally disposed open burners without valves I am enabled to use with perfect success a very low grade of crude petroleum. [In which case the valve K will be a check-valve.] This feature is of great importance in the economical use of a heater of this kind, for with the heaters in which valved burners were employed it was necessary to use a grade of gasolene costing from nine to twelve cents a gallon, while I have successfully operated a machine constructed in accordance with my present invention with crude petroleum costing but three cents per gallon. Furthermore, there are no burners to be burned out, with the attendant delay and expense occasioned thereby, and a much more practical and satisfactory result is produced in the use of the machine."

Adjourned to 2 o'clock, p. m.

2 o'clock, p. m.

(Answer continued.) The Defendant's device responds as fully to the claims of the patent 560,599, as it does to the drawings and specification proper, meeting them not only literally, but in full spirit and purpose. Under the stipulation submitted to me, Defendants' device is "an apparatus for repairing asphalt pavements," as specified at the opening of each of the claims of this patent in suit. Reading the first claim thereto said Defendants' device presents:

47

"the combination with a hood of one or more burners arranged to discharge horizontally into the hood, said hood being closed at the top, sides and one end thereof, and arranged to confine the heat to the limits of the same, substantially as described"

and shown in the patent in suit.

Reading claim 2 to said Defendants' device, the device presents

"the combination with a hood open at one end thereof of one or more burners arranged to discharge into the other end of said hood, said hood being arranged to confine the heat to the limits of the same."

Having claim 3 in mind, Defendants' device contains

"the combination with a hood closed at one end and open at the other and provided with one or more perforations in

the closed end thereof, of one or more burners arranged to discharge into the hood through said perforations, said hood being arranged to confine the heat to the limits thereof."

I do not think the claim necessarily implies that the nozzles terminate outside the end of the hood and that the flames are made to pass through holes in the hood, or to exclude the projection of the nozzles through the holes in the hood, so long as the flames begotten or initiated at or adjacent to the closed end of the hood having perforations, may sweep along the length of the hood to the opposite open end thereof. Hence, I regard defendant's device as answering to claim 3 just quoted from.

48 Defendants' device responds to claim 4 in that it contains

"the combination with a portably mounted reservoir, a hood, and a supply pipe leading from said reservoir and disposed underneath the hood, of one or more burners connected with said pipe and arranged to discharge horizontally into the hood, said hood being arranged to confine the heat to the limits thereof."

In like manner Defendants' device answers to claim 5 since it presents

"the combination with a portably mounted reservoir, a hood, closed at the top, sides, and one end thereof and a supply pipe leading from said reservoir underneath the hood and terminating at a point beyond one end of the hood, of one or more burners connected with said supply pipe and arranged to discharge horizontally into the hood."

Taking up the patent number 542,349 in suit, and claim 1 thereof, the character of the valve which I have marked K in the drawing of Defendants' device may be important in the comparison of said device with the patent.

In the patent, as already pointed out, the supply pipe leading to the burners is directly exposed to the flame blast beneath the hood and, in the absence of an effective check-valve in said supply pipe, by reason of such exposure thereof to the flame blast produces a back pressure in the reservoir, and thus obviates the need for so frequent manipulation of the air pump. The first claim (which is the claim in suit) only calls for the exposure of the supply pipe "to the heat of the burners" and there are advantages other than that of giving the back pressure in the reservoir resulting from such exposure of the supply pipe. But the patent refers to no other advantage than that of producing such

49 back pressure, and this back pressure will be prevented, and the only advantage mentioned in the patent will be defeated, if the valve which I have marked K in the drawing of Defend-

ants' device be an effective check-valve. Hence, notwithstanding Defendants' apparatus may, as it certainly does, answer to the terms of claim 1 of patent 542,349, it may not be held to conflict with that claim, taken in connection with the specification, when Defendants' valve K is an effective check-valve and not a "cock-valve" or one-way plug.

The supply-pipe, being extended in a coil under the hood in Defendants' device, is most effectively "exposed to the heat of the burners," and Defendants' device, therefore, responds perfectly to the terms of claim 1 of patent 542,349, which reads,

> "1. In an apparatus for repairing asphalt pavements the combination with a series of hooded fluid burners and a reservoir for supplying fuel thereto, said reservoir and burners being portably mounted, of a supply pipe connecting the reservoir with the burners and exposed to the heat of the burners, substantially as described."

The advantage which I have referred to as being present in this construction other and independently of the advantage of back pressure which is mentioned in the patent, is that such exposure of the supply pipe constitutes the supply pipe itself a vapor generator back of the burners so that only vapor is emitted in the flame jets. This advantage is present in the apparatus whether the valve K of the drawings of Defendants' device be a check-valve or an open valve, or whether a valve of either description be present in the supply pipe or not. The advantage mentioned in the patent will be realized only if the valve at K be an open valve or if it be a check-valve of such defective construction or defective operation as will allow the vapor or so-called gas to flow back towards the reservoir and give or maintain the desired pressure in said reservoir.

Not having carefully inspected this valve in Defendants' machine I can not say from personal observation whether it is a "cock-valve" or a check-valve, or whether, if it be a check-valve, it be of such construction or such defective operation as to actually permit a back-flow of vapor past it. I only know that a valve externally resembling a "cock-valve" is there present in Defendants' machine, and that it is said by one of Defendants' men who appears to be familiar with the construction of the machine to be a check-valve.

Wherefore, I repeat in conclusion, that Defendants' machine responds to the terms of claim 1 of the patent 542,349, and will have one of the advantages of the construction defined in said claim, but that whether or not it has the other advantage and

the only one mentioned in the patent, will depend, first, upon whether or not the valve K in the drawing of Defendants' device is in fact a check-valve or an open one; and, second, upon whether, if said valve be of check-valve construction, it is actually effective to prevent back passage of vapor from the exposed supply pipe to the reservoir.

O. 8. Take up the method patent No. 501,537, and compare with it, and especially with claim 1 thereof, the method of repairing asphalt pavements set forth in the stipulation referred to in my last question.

A. It is my opinion that the stipulated operation performed by Defendants with Defendants' machine in the repair of pavements is a practice of the invention set forth in said method patent and defined in claim 1 thereof.

51 Defendants' device being an apparatus which applies heat to the surface of the pavement by means of a blast flame, essentially as contemplated in the method patent in suit, and as performed by the adequate apparatus shown in said method patent in suit, it is evident that the same degree of heat may be applied in the same expeditious, certain and effective way by Defendants' device as by the device shown in the letters patent. It is also evident from the terms of the stipulation that the method in suit is complied with by Defendants with respect to the degree and extent of the melting or softening of the surface asphalt at and around a defective spot in the pavement, that is contemplated in the method patent in suit. It is further evident that in such use of Defendants' device and in the repair of pavements in part by the use of said device by Defendants, the use of tar or any other cement or "solder" is obviated, that the union between the patch of new material and the old pavement is direct, immediate and complete without the intervention of an interposed body of tar or like material, and that the joint need, therefore, present none of the disadvantages, objections or defects in respect either of appearance or of effectiveness, which distinguished the old tar joint and which are obviated by the method here in controversy.

The scraping off of the surface of the old pavement after softening it, to the extent of half an inch or so, is not, in my opinion, a departure from the invention set forth in the patent, and is only what I understand the patentee of Complainant's patent promptly commenced to do in the early practice of the method referred to. Moreover, it is, in my judgment, only what a judicious workman would do in order to get rid of the powdered

material and impurities originally placed upon the surface of
52 the pavement or subsequently accumulated therein, so as to give a fresh surface of the old material for contact and union with the fresh new material added. It is only a question of adding so much more of the new material to make up for the old material scraped away. The statements of the stipulation as to what Defendants have done clearly answer to the terms of claim 1 of this patent which I again quote as follows:

"1. The method of repairing asphalt pavements which consists in subjecting the spot to be repaired to heat, adding new material and smoothing and burnishing, substantially as described."

There are three steps or process elements enumerated in this claim, to wit: First, "subjecting the spot to be repaired to heat"; second, "adding new material"; and third, "smoothing and burnishing." These are all performed in the same order by the Defendants. The separate steps, are, moreover, essentially the same in kind in Defendant's practice, as set forth in the patent. The heat is applied to the spot to be repaired with a flame blast. The new material added is the same in condition and character; it is not tar or any part tar, but is solely the asphalt composition like that of the old pavement, and in the soft condition and heated state in which said composition is and was originally applied. The smoothing and burnishing is the same step in both cases, being the old and familiar operation performed by means of heated metal tamping and smoothing irons long before used in leveling and smoothing original asphalt pavement surfaces.

The results of Defendants' operation are also the same as the results set forth in the patent. The use of tar or equivalent interposed cement is obviated, and nothing of this nature
53 exists between the patch and the original pavement in the completed job. On the other hand, there is a direct union between homogeneous materials and, as a consequence, there is a perfect continuity in appearance as well as in fact, and there is no liability of the breaking away of the patch from the pavement by the yielding of an interposed cement. In addition to these results relating to the character and efficiency of the completed work, there is also the same result as to the expedition and cheapness with which the work of repair may be effected. There is, therefore, perfect identity between the method practiced by Defendants and that set forth in the patent and specified in claim 1 thereof, with respect to the nature and order of the steps involved and to the results and advantages claimed. If the removal by

Defendants of a shallow portion of the surface asphalt which is not mentioned in the patent, though practiced by Complainant, be regarded as a difference from the patent, it is, nevertheless, in my judgment, not a departure from the patent, but is merely an addition of a step to the three steps enumerated, and one which, moreover, does not affect the character or result of said three steps further than that it is a prudent expedient to make said three steps the more effective.

I do not overlook the fact that the specification of the patent 501,537 provides for an additional step, namely, the agitation or stirring up of the softened material of the old pavement preliminary to the addition of the new material. But this is not included in claim 1 here in suit. On the other hand it appears to be expressly excluded from said claim by its specific inclusion in claim 2. Moreover, such stirring or agitation of the old material 54 can have no other effect than to roughen its surface and to thus allow parts of the new material to intermingle or interlock with parts of the old, and this is practically accomplished, in my understanding, by the removal or raking of a shallow portion off of the old pavement, as practiced alike by Defendant and Complainant.

In view of the foregoing considerations, I regard the operation of repairing asphalt pavements with the aid of the flame blast apparatus, all as set forth in the stipulation referred to, as being a practice of the method set forth in the complainant's patent No. 501,537, and specified in claim 1 thereof.

Adjourned to Friday, September 17, 1897, at 10 o'clock a. m.

September 17, 1897.

Met pursuant to adjournment.

Present, as before.

Q. 9. Please state whether or not the inventions specifically claimed in the seven claims herein sued upon are capable of conjoint use?

A. They are.

Q. 10. Does the valve K shown in the drawing of Defendants' device, appear from the face of that drawing to be in any essential particular different from the valve K shown in Fig. 1 of the drawings of the apparatus patent No. 560,590.

A. It does not.

Q. 11. Is there anything which appears on the face of the drawing of Defendants' device, or in the stipulation herein re-

lating thereto, which in any way indicates or intimates that the valve K is other than a cock-valve?

55 A. There is not.

Q. 12. Do you know under whose direction the drawing of Defendants' device, here in evidence, was made?

A. It was prepared under the direction of Mr. Smith, a practical man in the employ of the defendant, who, after I had produced a rough sketch, was called in by Defendants' counsel to direct the preparation of the finished drawing or tracing referred to, to wit, "Complainant's Exhibit, Defendants' Device."

Cross-Examination by Mr. J. H. Peirce.

X. Q. 13. Suppose it should appear, as a matter of fact, that the valve K, as used in Defendants' device, was not a "cock-valve" but was a "check-valve," what of it?

A. In that case, which I considered in my answer to question 7, and as I there stated, there would, in my opinion, be a question for the Court to determine whether or not Defendants' device or apparatus infringes the first claim of the apparatus patent No. 542,349, because, although the Defendants' device appears to respond fully to the terms of said claim and would, in the supposed case, realize a certain advantage of the construction defined in that claim, it would not realize the particular advantage set forth in said patent specification.

X. Q. 14. You speak of producing a "rough sketch" after which this exhibit drawing, "Defendants' Device" was prepared under Mr. Smith's direction; who made the rough sketch referred to?

A. I did.

X. Q. 15. Did such sketch purport to show Defendants' machine?

56 A. It did so purport, and it did so show, in general and roughly.

X. Q. 16. Had you seen Defendants' machine before the sketch was made?

A. I had.

X. Q. 17. Was such machine then in operation?

A. It was not.

X. Q. 18. Did said machine have a valve at the place marked K, in this exhibit "Defendants' Device"?

A. It did, as to external appearance.

X. Q. 19. What sort of a valve did it appear to be to you?

A. Having a squared plug in its top, I took it to be a stop-cock or valve of the one-way plug order.

X. Q. 20. On that machine was there an adjacent valve, as at the point marked L on the "Defendants' Device"?

A. There was a hand-wheel valve.

X. Q. 21. The hand-wheel valve mentioned would be of the "one way order," would it not?

A. Not of the one-way plug order, but of the order known as globe-valve, in which the stem projecting from the hand-wheel is a screw, and is provided with a disk at its lower end having a tapered edge which seats in a tapered seat or passage in the horizontal portion of the deflected diaphram within the globe or bulb of the casing. This valve has only a single passage which may be opened a greater or less distance by rotation of the screw stem of the hand-wheel and is especially intended and adapted to regulate the flow of the liquid fuel as well as to shut off the flow entirely.

57 X. Q. 22. What would the one-way plug valve K do, which the globe-valve L, adjacent thereto, would not?

A. It would serve here as a general protection against the mischievous opening of the pipe and the discharge of the contents of the reservoir when the apparatus is lying about out of use. It is provided only with a square for a wrench, and, therefore, requires a special tool to open it. On the other hand, the globe-valve, with its always present hand-wheel, besides being liable to be started open by an accidental movement of the hand-wheel, presents a tempting means to a small boy for opening the valve.

X. Q. 23. Who made this exhibit "Defendants' Device"?

A. Mr. Rheem, a draughtsman in this city.

X. Q. 24. At whose request did Mr. Rheem make it?

A. It was requested by counsel for Complainant that a careful drawing be made by Mr. Rheem to meet the full approval of counsel for Defendants, in place of the temporary and rough sketch which I had produced, and for use in connection with the stipulation which accompanies the drawing.

X. Q. 25. At the time Mr. Rheem received his first instructions respecting this exhibit "Defendants' Device," he was in attendance at the office of Mr. Raymond, counsel for Complainant, was he not?

A. He was.

X. Q. 26. Who were there beside, at that meeting?

A. Counsel for Defendants, the Mr. Smith heretofore referred

to as one of Defendant's employes, and Mr. Culmer, an officer of the defendant company.

58 X. Q. 27. Did you hear Mr. Smith say that the valve marked K on this exhibit drawing "Defendants' Device," was a check-valve?

Mr. Barnett: Objected to as immaterial.

A. I did, and I have so stated in my direct.

X. Q. 28. After this exhibit drawing was finished, do you know that Mr. Smith's attention was specifically directed to the appearance of valve K, as shown on the drawing, and which seems to show it as a cock-valve?

A. I do not know, but I do know that it corresponds in appearance, externally, with the description given to Mr. Rheem and myself by Mr. Smith at the interview referred to, and I will add, that its external appearance is consistent with its being a check-valve of the particular kind Mr. Smith stated it to be at that time, namely, a check-valve having a hinged depending flap which closes upon a vertical or inclined seat around a horizontal opening or passage. This is a form of check-valve which is not common, I believe, so that I was first led to take the valve to be a stop-valve, which it also resembles externally.

X. Q. 29. The Perkins Patents here in controversy relate to the repair of asphalt pavements; what is an asphalt pavement?

A. It is a pavement of which the surface layer is a composition into which asphalt enters as an ingredient. The pavement as now made usually comprises a foundation or bed-laver of grout, a layer resting upon the grout, of broken stones cemented together by asphalt, the fragments of stone being about half or three-quarters of an inch in diameter, and a top layer of asphalt composition composed of about seventy-five per cent sand,

59 fifteen per cent asphaltum containing a small quantity of residuum oil, and ten per cent of lime stone flour. The foundation course or bed of grout may be several inches in thickness, the intermediate layer or binder of broken stone and asphalt is about an inch or an inch and a half in thickness, and the superficial laver of asphalt composition is about an inch and a half or two inches in thickness. A sprinkling of fine granulated cement is thrown or swept over the top of the pavement after it has been smoothed and leveled, and this may be said to form a part of the pavement, inasmuch as it adheres to and becomes embedded in the immediate surface of the asphalt layer.

X. Q. 30. What is the "asphaltum" which you mention as an ingredient in the top layer of "asphalt composition"?

A. It is a mineral product of a bituminous character, as I understand it, sometimes called mineral tar.

X. Q. 31. Do you know that this "asphaltum" melts at about the temperature of boiling water?

A. I do not know it specifically from any experiments or observation of the exact temperature at which it melts, but I should say that that would be the fact.

X. Q. 32. From the Century Dictionary, under the title "asphalt" the statement is: "In the United States the substance so named is commonly made of refuse tar from gas houses mixed with slaked lime and gravel. Also called asphaltic cement." If a pavement had a top layer in which the "refuse tar from gas houses" was employed in lieu of the asphaltum or "mineral tar," would the repair of such a pavement, according to the Perkins inventions, be an infringement thereof?

60 A. I don't know of any reason why it would not be.

X. Q. 33. You are aware, I suppose, that the early asphalt pavements at Washington employed the tar or pitch from gas houses in lieu of the asphaltum or mineral tar, as an ingredient for the top layer of the pavements; am I correct?

A. I don't know whether or not that is the fact.

X. Q. 34. Are the several Perkins inventions here in suit applicable for the repair of sidewalks, allevs, viaducts, sub-way, tunnels and cellars, as well as for the repair of pavements?

A. I suppose the question means the flooring of the places referred to, and in that case I understand them to be pavements in fact, and to come under the term pavement as employed in the patents.

X. Q. 35. Will you give us an idea of the nature and causes of the defects in a pavement which leads to a resort to these several Perkins inventions for the purpose of repairs.

Mr. Barnett: Question objected to as immaterial and irrelevant.

A. I don't know that I can do so as to all the causes which practical men in the art of asphalt pavements have discovered. I have observed cracks in pavements which seemed to have been produced by contraction under extreme changes in temperature, and others which appeared to have resulted from heaving. I have also observed depressions (which constitute defects), which appeared to have resulted from local settling; and I have also observed broken spots in pavements where the surface is dis-

61 integrated, from what special cause I do not know. I have also observed defects resulting from a car running off the

track upon the pavement, perhaps before becoming completely set and hardened, or when in some degree softened by extreme heat of the sun. I have also seen spots where injury to the pavement has been inflicted by the stamping of a horse, left to stand for a long time in one place. Further than these, I do not now recall.

X. Q. 36. Are said Perkins inventions directed to the repair of any other than the top layer of pavements made up as you state, of the asphalt composition?

A. I think not. That is to say, the method claim pertains exclusively, as I understand it, to the repair of the surface of asphalt pavements, and the machine patents, in so far as they relate to the use of the machine there described in the repair of asphalt pavements, are intended specially to carry out, or assist in carrying out, the method of the process patent. There is, of course, nothing to prevent the use of the machines for any purpose for which they are adapted, including a treatment of, say, the binder course of a pavement, if necessary, or the softening of the surface of a Klondike gold mine.

Adjourned to 2 o'clock p. m.

2 o'clock p. m.

X. Q. 37. In repairing pavements according to the method claimed under Perkins Pat. No. 501,537, what result ensues on "subjecting the spot to be repaired to heat" which would not ensue if such heat were omitted?

A. The heating contemplated in this patent is such as to melt the top of the asphalt layer to some suitable depth and to reduce it to the condition of softness in which it was originally laid; this is the immediate result. As a further result the
62 old surface material is adapted to be removed or broken up by raking or otherwise, so as to present fresh and broken surfaces for contact with new material added; and, as a still further result, the new material applied in a heated state is adapted to be amalgamated with the old material at the edges and bottom of the patch (so to call it) and thus, upon the application of the tamping and smoothing irons, will form an imperceptible and integral joint.

X. Q. 38. Owing to disintegration at a given spot, let us assume that the top portion of the pavement there, i. e., the asphalt composition layer, has quite disappeared thus exposing the binder layer next beneath. The operator sweeps the spot clean, heats it with a charcoal brazier or salamander fire, sprinkles

a dope of coal tar or liquid asphaltum—heated—about the border and over the surface of the exposed binder layer; fills the hole with fresh, hot asphalt composition, levels, stamps and burnishes the filling and finishes the job: Would such procedure involve the practice of Perkins' method as claimed by patent No. 501,537?

Mr. Barnett: Question is objected to as being indefinite unless it shall indicate more clearly what is meant by "the spot" which is assumed to be heated with a charcoal brazier or salamander fire, whether the exposed binder layer or otherwise.

Mr. Peirce: Mr. Witness, do you understand my question?

Mr. Barnett: This last question is further objected to, as whether the witness understands the question or not is not material unless the question is sufficiently clear on its
63 face for the purpose of this record, or, unless the witness sees fit to state what his understanding of it is.

A. Replying to the last question which asks if I understand the question preceding it, I answer that I think I do.

X. Q. 39. In such view kindly proceed to deal with my hypothetical question, i. e., X. Q. 38.

A. I do not think it would.

X. Q. 40. Why would such procedure not involve said Perkins method?

A. Primarily such procedure would be the old tar method of patching, and, in the nature of the case, that is, by reason of the application of the tar, union and even contact of the old and new materials of the pavement will be prevented. The integrity of the patch with the body of the pavement aimed at and accomplished by the method of the patent is, therefore, impossible, and the advantages of such integrity of the parts, as set forth in the patent, are unachieved. On the other hand, all the defects of the old tar method of patching which the patent seeks to obviate, are present. It appears to me to be a feature of the patented method, or a characteristic of the steps of applying the new material, that the new material is placed into direct contact with the old, as if the claim read "adding new material in direct contact with the old material and smoothing and burnishing it."

X. Q. 41. The conditions otherwise being the same as stated by my hypothetical question, let us suppose that the top layer of asphalt composition is two inches thick; is disintegrated to the depth of one inch, and that the remaining inch, on being

softened by the salamander fire, is raked off clean, leaving
64 the binder layer exposed, while the subsequent procedure defined by the question, i. e., sprinkling the spot with dope, et seq., is still preserved. Would such a mode of treatment fall within said Perkins method, and if not, why not?

A. In my judgment it would not and for the sufficient reason given in answer to cross question 40.

X. Q. 42. And what do you say if the softened remnant of the asphalt layer were left in situ after heating but were coated with the hot tar or asphaltum and the filling and finishing of the spots were proceeded with as defined by my hypothetical question X. Q. 38?

A. I would say the same as in answer to said X. Q. 38, which is given in answer to X. Q. 40, and in my last answer.

There is, at best, in the supposed procedure a failure to comply with the step of "adding new material" which, according to the patent, is the adding of new material directly in contact with the old, such new material being the asphalt composition and not the different material of tar or its equivalent, melted asphalt. In other words, the supposed procedure does not involve the abolition of a cement or what the patent calls a "solder."

X. Q. 43. Recurring to the procedure defined by method claim 1, in Perkins' Pat. No. 501,537, do you say that the terms thereof would be satisfied if the spot to be repaired were heated by means of a brazier or salamander fire, in lieu of the gasoline burner fire set forth by the patent; the conditions otherwise being the same as defined by said claim?

A. I am not able to say. I believe that a brazier with a fresh and properly charged fire in it could be used for the purpose of heating the surface of the asphalt layer with the effect con-
65 templated in the patent, namely, that of melting the "surface asphalt" and reducing it to the condition of softness in which it was first laid and suitable for its being raked or scraped to expose its inner and fresh surfaces for direct union with similar new asphalt composition, as proposed in the patent in suit. I, therefore, believe that a brazier could be employed for the work of heating referred to in the patent, but whether the patent is restricted to the use of a blast-flame in fulfillment of the stated object of accomplishing the repairing "quickly and cheaply" is, it seems to me, a question which will depend, first, upon whether the blast is, in fact, more expeditious and cheaper than the brazier system of heating and, second, whether the prior art which the defense may develop, shall show a necessity for so restricting

the patent and claim. I am unable to state what the relative merits of the two heating devices are, or what the prior art may finally show to be old.

X. Q. 44. Which device is capable of developing the higher heat; the gasoline burner disclosed by Perkins' Pat. No. 501,537, or the ordinary charcoal brazier or salamander?

A. I am unable to say, not having made comparison of the two.

X. Q. 45. You have no opinion upon this point which you would venture to express?

A. I have none. As to the brazier, it is obvious that its action will depend upon the distance at which it is supported over the pavement, upon the condition of the fire therein, upon the draft of the fire as affecting the rapidity of combustion and the incandescence of the coals, &c.

X. Q. 46. Suppose you were to kindle a bright, log fire directly on the spot to be repaired, would the heat thence obtained suffice to satisfy the prescription of method claim 1 in Perkins' Pat. No. 501,537; the conditions otherwise being the same as there stated? 66

A. I do not think it would. A bright log fire is a good thing with which to thaw out frozen ground to a considerable depth, as I have seen it employed in making street, sewer and water pipe repairs, and it would be a good enough thing with which to burn and melt out the entire depth of an asphalt pavement, or for softening it in cold weather so that it could be chopped out; but it is not, in my judgment, a suitable means for making a limited repair in the "surface asphalt" of a pavement where the object is to heat and soften a limited extent of area and depth and with substantial uniformity, so that the repair may be restricted practically to the defect to be remedied and waste or unnecessary consumption of new material may be avoided. All such wood fires as are described in the question are liable, in the nature of the case, to heat to different degrees different parts of the underlying surface and to burn some portions while failing to adequately heat others.

X. Q. 47. Should the wood fire in question "burn some portions" of the pavement, what specific ingredient or ingredients thereof is thus "burned"?

A. This appears to me to be a question in chemistry in which I am not an expert, but, answering to the best of my ability, I understand that the sand which forms about seventy-five per cent. of the composition is not burned; the limestone powder is not burned and the non-combustible elements of the asphalt and of

the residuum oil are not burned, but that the carbon of the asphalt and of the oil are burned.

67 X. Q. 48. If the asphaltum present as an ingredient of the composition layer is not burned or coked under the conditions stated, do you say that such ingredient is non-combustible?

A. I understand that there are non-combustible elements in the asphaltum and in the residuum oil, and that after the combustion of such combustible materials as are at present in these ingredients, and the volatilization of such constituents as will be thus acted upon and thereby eliminated, it is my understanding that incombustible and non-coherent constituents are left.

X. Q. 49. So far as the asphaltum present in the top pavement layer is "burnt" by the heat of the wood fire, as suggested, the asphaltum loses its cohesion; am I correct?

A. It is my understanding that the overheating resulting in what is called "burning" of asphaltum composition used in pavements, whether performed by one means of heating or another, is destructive of the cohesiveness and generally of the usefulness of the material for paving purposes.

X. Q. 50. Do you understand that the "heat" described in claim 1 of Perkins' Pat. No. 501,537 is such as will melt (without "burning") the composition beneath and thus bring it to substantially the same degree of softness as the new material to be added?

A. The heat described in the patent is such as to effect the result stated in the question, and the apparatus for supplying the heat, being capable of regulation as to the flames, would seem to be such as might be able to give this result. The language of the patent is (page 1, line 79):

68 "As explained above when it is desired to repair a spot the apparatus is moved adjacent thereto with the burners directly above the spot. These soon reduce the surface asphalt both at the spot and at the surrounding edges to a pliable state, the strong blast causing not only the immediate surface, but the particles deep down to be melted and yet not burned."

Elsewhere, to-wit, in the sentence beginning at line 39, page 1, the surface asphalt is said to be "reduced to the soft pliable state in which it is originally laid."

X. Q. 51. If the degree of heat were such as to not only melt but also to burn the immediate surface and as well "the particles deep down", would such procedure be an infringement of Perkins'

method claim 1; assuming that the old layer thus burned were raked away clean before the new filling was supplied.

A. I think it would. There must be a melting in advance of the burning and the removal of the burned part would leave the unburned and melted part in condition for direct union with new material added to fill the place. This might be regarded as perhaps, in a degree, a wasteful mode of employing the process, or, on the other hand, as an economical mode, in view of the less care that would be required in regulating the heat or time of exposure and in view of the purpose to in any case take off the immediate surface as the best means of obtaining a fresh surface for contact and union with the new material to be added.

X. Q. 52. If the operator, after heating and raking off the burned material as suggested in my last question, should leave the spot to cool down and later return there again, softening the edges of the hole by piling the hot new material thereon, then coating the edges and bottom with hot tar or asphaltum and finally raking the new material into the depression, and
69 smoothing and finishing as usual. Would such practice be in accord with the subject-matter specified by claim 1 of Perkins' Pat. No. 501,537?

A. I do not know that I exactly understand the question. It assumes that the asphalt around the excavation made after heating is first allowed to cool and harden and is then again heated by piling hot new material upon the old surface around the excavation so that the edges of said excavation are, as I understand it, in a soft condition when the new material is pushed into the hole from around it to fill the latter. But before pushing the new material into the hole the edges and bottom of the hole are coated with tar. After the hole is filled with the hot new material I am not certain whether the "raking" mentioned in the question involves the mixing of the old material around the margin with the new material inserted in the hole and with the tar applied to the edges of the hole, or not. If the old and new asphalt materials are mixed with each other and with the originally interposed tar, then I should think that, as to the edges, there might be such a direct union of the old and new material as the patent contemplates, both being only somewhat reduced or diluted by the added tar. If there be no such inter-raking of old and new materials there would, in my judgment, be no practice of the invention at any part of the repair.

X. Q. 53. And would your answer be the same if the dope of hot tar or asphaltum, suggested by the question, were omitted?

A. No. There would then be no question, in my judgment, that the invention of the patent would be practiced.

Adjourned to September 18, 1897, at 10 o'clock a. m.

September 18, 1897.

70 Met pursuant to adjournment.

Present, as before.

Cross-Examination of Melville E. Dayton continued by Mr. Peirce.

Mr. Peirce: Before proceeding with the further examination of the witness, I desire to say that: Since the testimony of Mr. Dayton—Complainant's expert—was begun, I have been informed, for the first time, that it is customary practice with the defendant Co., in making asphalt pavement repairs to apply a coat or "solder" of melted asphaltum to the clean, exposed surfaces of the hole or spot just before the new asphaltum composition is filled in. Whether this is the invariable practice, I do not know thus far.

The stipulation between the parties now of record and which deals with Defendants' repair procedure is silent on the detail above specified, and I regret that such particular should have been overlooked, although I was ignorant of the fact, and suppose that the Defendants' employes with whom I conferred, did not recognize the seeming significance of the detail.

At present I am trying to verify the correctness of my information touching the use of the "solder" of melted asphaltum as stated with the endeavor to rectify the omission of said stipulation on such point or to permit Complainant to offer testimony directed to this particular of Defendants' practice, as counsel may be advised.

Mr. Barnett: Solicitor for complainant objects to the
71 above statement at this point, before the completion of the deposition of Mr. Dayton, his deposition having proceeded thus far on the stipulated statement of facts, and the redirect examination of this witness as so far planned by solicitor for complainant being intended to bear directly on the points involved in the statement of Mr. Peirce. Such redirect examination, necessarily having to follow the statement of Mr. Peirce made at this time, and the witness' answers thereto may seem to be influenced by the statement of Mr. Peirce when such, in fact, is not the case.

Further, Complainant's solicitor submits that in drafting the stipulation of facts which has been agreed to by the parties hereto and, as he understands, after submission to Mr. Culmer, an officer and practical man of the Defendant Company, he described the method used by the Defendant Company as he was informed that it actually was practiced in the making of small repairs, and without involving the use of a coating of tar, liquid asphaltum or other "solder."

X. Q. 54. What specific quality inheres in coal tar which renders it objectionable as a "solder" or dope when applied to the exposed surface of the spot to be repaired just prior to filling in the new asphalt composition?

A. Referring to the patent for a reply on this question, and having reference to the use of the tar "solder" as employed in the prior art recognized by the patent (in which prior art I judge that there was no material heating or softening of the material around the excavation, and that such surrounding material was not
72 in a soft condition at the time of applying the tar), I understand that the quality in the tar which caused it to serve as a solder or connection between the old and new material was its adhesiveness. The statement of the patent is (line 13, page 1):

"When the [old] material has been removed the depression thus made is thoroughly cleaned and given a coat or dressing of tar. New material in a heated state has then been placed in the depression and been ironed down and smoothed off in the usual manner of finishing, the tar acting as a solder to hold the new material in place.

The objectionable feature of this interposed tar thus applied to unite the practically hard and unheated wall of the excavation to the margin or surface of the new material, is that it forms a distinct body of material which is not homogeneous with the materials between which it is interposed (being destitute of those ingredients which in the pavement give strength and permanence), and that it is liable, therefore, to give way and to release the patch under strains due to changes of temperature, for example, when the pavement is subjected to further use. Another objectionable feature mentioned in the patent and due, evidently, to its being a material different from the composition to which it is applied, is that it is unsightly, making, as the patent says, a "plainly discernible" line.

X. Q. 55. Would the same objection exist if melted asphaltum were used as a "solder" instead of hot coal tar, or coal tar pitch?

A. I am unable to speak concerning any specific differences which may exist between tar, referred to in the patent, and as-

phaltum, but I have heretofore regarded the two equivalents
73 and as productive of the same objectionable results in use by the former method described in the patent. To anticipate somewhat a statement which I expect to be afforded opportunity to make hereafter in this examination, but here confining myself to this question, I should say that the objectionable results of the use of any material such as melted tar or asphalt will be, in large measure, due to the condition of hardness of the wall or surface to which the tar or asphalt is applied for the purpose of serving as a "solder." In other words, when applied to a hot and disintegrated and broken or loose surface, the hot material applied as a dope may be dissipated by penetration, or even by mixing in the act of its application, so as to lose its identity to a greater or less extent; and there may be a difference of which I can not now speak between the tar referred to in the patent, and the asphalt referred to in the question.

X. Q. 56. Why can you not now—as well as later on—speak of the possible difference between the tar referred to in the patent and the asphaltum referred to by my question just prior?

A. Because I have made no direct comparison of the two, and because, without such comparison, I am unable to say whether or not there is a difference.

X. Q. 57. By making no "direct comparison" do you mean you have made or observed no direct experiments, or merely that you have made no direct discussion between the two in the testimony thus far?

A. I mean that I have made no experiments or observations in the nature of a comparison.

X. Q. 58. According to Perkins' Pat. No. 501,537 (p. 1, line 85), the blast flame is said to cause:

74 "Not only the immediate surface, but the particles deep down to be melted and yet not burned."

This avoidance of "burning" as specified, is it of the incipient sort such as a flap-jack experiences when it escapes scorching, or is it of the extreme sort, as when the flap-jack shrivels up and consumes away to an ash?

A. It is not necessary to be either of these. I understand the term "burned" to have reference, in the patent, to the condition produced by heat in which the material said to be burned is injured for the purpose a pavement, and I understand the whole statement of the patent referred to in the question, as being descriptive of a result of an operation capable of performance by the apparatus mentioned in the preceding sentences of the same pat-

ent. The burning of the surface of a flap-jack (and I am an expert on flap-jacks) which consists only in the browning of the surface along with the cooking of the interior, is not harmful to the article for its intended purpose, but the burning which causes it to shrivel and turn to ash, as described in the question, is, on the other hand, destructive of the flap-jack for food purposes.

X. Q. 59. With the description existing as at present in the Perkins Pat. No. 501,537, Defendants expect to show in due course, that the application for such patent originally contained a claim as follows, viz:

"3. The method of repairing asphalt pavements which consists in subjecting the spot to be repaired to a strong blast of heat, adding new material and smoothing and burnishing it, substantially as described."

On comparison of such claim with present claim 1, of said patent it appears that the spot to be repaired is subjected in one instance, to "a strong blast of heat" while in the other or patent claim 1, it is subjected "to heat." What force, if any, do you give to the words "strong blast of heat" in distinction from the more general term of "heat"?

Mr. Barnett: Objected to for the reason that the question calls for a consideration by the witness of a segregated part of the contents of the file wrapper of the application for the patent mentioned, without giving the witness an opportunity to consider the quoted phrase and alleged original claim with legitimate reference to the whole of the contents of the file wrapper.

A. I prefer to express no opinion on the matter inquired of in the question, because I have not seen the file wrapper and contents, and do not know under what circumstances the alleged original claim was supplanted by the first claim of the patent.

X. Q. 60. For your fuller information I desire to say that the application for such patent originally contained, as I am informed, the existing claims 1 and 2, and the additional claim 3 I have quoted, but none other beside. The description and drawing of the patent were the same when said claim 3 was originally present as such description and drawing now appear in the patent. With this further explanation, do you choose to respond to my prior question?

Mr. Barnett: The last objection is repeated, and this question is further objected to as asking the witness to give an answer based upon Mr. Peirce's conclusions as to a part of the contents of the file wrapper of the application for this

patent. It is further objected that nothing contained in the
76 file wrapper can have any significance, or can be properly considered by the witness except in the light of the entire contents of the file wrapper, including the letters of rejection and any references therein cited, if in fact, there were any such letters of rejection or references. And Defendants' solicitor having here in his possession at this examination the original office file of the application for this patent as kept by the solicitors who obtained this patent, he is requested to submit the same to the witness, if he desires to examine the witness in this connection.

Mr. Peirce: By my question I have laid before the witness all of the material, including description, drawing and claim, which were laid before the Patent Office, as I understand, by Perkins' solicitors, who are Complainants' counsel in this cause, at the time the application was originally entered. Presumably some distinction was attempted to be drawn between the use of "heat" as specified by patent claim 1, and the use of "a strong blast of heat" as specified by original claim 3 now eliminated. I asked the witness to act upon the data which Messrs. Raymond & Omohundro presented to the Patent Office, and which the Patent Office had occasion to consider in dealing with the application as originally filed.

Mr. Dayton, will you kindly answer my question?

Mr. Barnett: In view of the preceding explanation by Defendants' solicitor, it is further objected that it is utterly immaterial what distinction the patentee's solicitors attempted to draw in their first draft of the claims submitted to the
77 Patent Office; and, further, that a comparison of the first draft of the claims with the claims as actually allowed, is utterly immaterial except when considered with relation to the data before the applicant's attorneys when the claims were put into the form in which they were allowed, and especially unless considered with relation to any communication from the Patent Office to the applicant with relation thereto, as to the existence of such communications, if any, and as to the contents of which the witness has not been informed.

A. The last question corrects a misapprehension into which I was led by the preceding question, and it may have begotten some further misapprehension, although on its face it appears perfectly intelligible and fair. Answering as I understand the question which is:

"What force, if any, do you give to the words 'strong blast

of heat in distinction from the more general term of 'heat'?

I reply that "strong blast of heat" is, as counsel says, less "general" than the term "heat," and this is true even if the term "heat" as employed in claim 1 of the patent be understood to mean "blast of heat", because a "blast of heat" may be either "strong" or weak, or it may be of intermediate force.

X. Q. 61. Referring to the apparatus invention here in suit, viz., Perkins Pat. No. 542,349, and Perkins Pat. No. 560,599, do you say that the improvements there set forth would be practiced if the carrying wheels employed to sustain the oil tank were omitted and supporting legs used instead?

Mr. Barnett: Question objected to as in substance asking the witness to state a matter of law, to-wit, whether a given construction would be an infringement, or, as the question says, "a practice" of the invention of these patents. While the witness may, as a matter of mechanics give his opinion as to identity or otherwise, of stated constructions, he is not authorized to say whether a given construction would, as a matter of law, be a practice of the invention.

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A. The carrying wheels referred to in the question are the devices which make the apparatus a "portably mounted" one, as distinguished from being merely a portable apparatus, which might exist without wheels. The words "portably mounted" are found, I believe, in only three of the machine claims in suit, to-wit, claim 1 of patent 542,349, and claims 4 and 5 of patent 560,599. It is my understanding that wheels or their equivalent as a "mounting" are called for by said claims which contain the words "portably mounted," said terms being limitations upon these claims. I have no opinion to express as to the remaining claims, that being clearly a matter of construction resting wholly with the Court.

X. Q. 62. The machines of these Perkins apparatus patents being otherwise unchanged, suppose the blast flame burners with appurtenant pipe and hood, instead of extending horizontally near the floor, were turned vertically upward so as to present the flame against an upright wall from which it was desired to remove a coating of paint and sand by scorching. Would that change involve a different embodiment of the device?

A. The arts for which the two machines are respectively adapted are widely remote, and the change in the machine, supposed in the question, appears to be a material one in that it is one necessary to adapt it for the different art. But this is not all the change or difference between the two machines,

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although no other is mentioned in the question. A machine of suitable size to remove paint from a vertical wall and otherwise of proper organization for the purpose, would, in these particulars alone, be unadapted for the repair of pavements, and vice versa.

Adjourned to 2 o'clock P. M.

2 o'clock P. M.

Re-Direct Examination.

R. D. Q. 63. Mr. Dayton, according to your understanding of the prior art in the repair of asphalt pavements, as it is referred to in the specifications of Perkins' method patent, did a necessity exist in the practice of such prior art for the use of tar or some equivalent substance as a cement between the exposed edges and surfaces of a spot to be repaired and the new asphalt composition added thereto in the making of such repairs?

A. Such necessity did exist, as I understand it, and for the reason that in such old procedure there was no material softening of the old asphalt composition about the excavation made and, therefore, no possibility of making a continuous or jointless repair by the addition of new material. The tar was requisite as a cement or "solder," to hold the patch in place.

R. D. Q. 64. In this connection, and as contrasted with the old method in which the necessity for the use of such a cement existed, please state in what manner the Perkins method of the patent in suit obviates the necessity for the use of such cement?

A. By the reduction by heat of the old material to the soft condition in which it was originally laid, and by the direct contact of the heated new material with the heated and softened old material.

R. D. Q. 65. So that if, in the repair of an asphalt pavement the old material is melted and reduced to its original condition of softness and a part of the old pavement has been removed so as to expose fresh surfaces, and hot, fresh asphalt composition is brought into immediate contact with such exposed and softened surfaces of the old pavement so as to cause an intermingling and union between the old and new material when the new material is tamped and burnished, there will be no useful reason, so far as you can see, for using a dope or cement of any kind between the new and old materials, will there?

Mr. Peirce: I would like to suggest to Complainant's counsel that he frame his questions in a less "leading" fash-

ion to obviate a formal objection for their obvious unfairness, in suggesting an answer to the witness.

A. That is my understanding of the fact.

R. D. Q. 66. If a repair be made in the manner set forth in the preceding question, except that before adding hot new asphalt paving composition to the exposed, fresh surfaces of the old pavement and while such exposed surfaces of the old pavements are still soft and heated, a very light coat of hot melted asphalt be applied to such exposed surfaces, and the hot, fresh composition be added immediately thereafter, what do you consider would become of the dope so applied; what purpose, if any, in the making of such repair, would the dope so applied serve; and what effect would such use of the dope have upon such method of repairing an asphalt pavement, as compared with the method of the
81 first claim of the Perkins method patent here sued upon? In this connection I call your attention to your answers herein to cross questions 38, 40, 42 and 52.

A. Upon a further reflection which I gave to the general cross questions to which I am referred in the concluding part of the above interrogatory, I had been led to think that a thin application of hot and, therefore, melted asphalt between a hot, soft, broken and porous marginal wall of an excavation in the surface of an asphalt pavement and the new asphalt composition, would, upon the tamping and further heating by the smoothing iron of the surfaces at the joint or union, be largely dissipated by absorption into both the old material and the new, and that by reason of the roughness of the old material at the edge of the excavation resulting from its having been broken away when hot, and by reason of the thinness of the asphalt dope, there would be a practical union between the old and the new asphalt composition brought together notwithstanding the application of such dope.

In making my answers to the before mentioned cross-questions, I had in mind (as indicated in some of said answers) the use of a dope like that of the acknowledged prior art, which, by its quantity and consistency, and by reason of the hard and substantially non-porous condition of the edge of old material, formed a septum which kept the old and new asphalt composition apart and prevented the union contemplated in the Perkins method patent. Reflection given to the matter between sessions of yesterday and to-day has led me to think that the literal condition of the cross-questions referred to might be complied with without the objectionable consequences attending the use of an interposed tar solder between the old and new material set forth in the

82 patent, and with substantially the same advantageous results set forth in the patent as belonging to the new method there disclosed. To this extent I wish to modify my answer to X. Q. 38, 39, 40, 41, 42 and 52.

Assuming the results to be as stated from the conditions named in the question and the foregoing part of this answer, it is my understanding that the dope would serve no useful purpose in making the repair, and would have no material effect towards the impairment of the integral union contemplated in the method of the patent referred to, and that the joint would neither present the appearance of a demarking line on the surface of the repaired pavement, nor in any considerable degree tend to render separation of the patch likely under changes of temperature and such other strains as are applied to the pavement in use.

In view of Mr. Pierce's statement upon the record at the opening of this morning's session, I beg to add that the conclusions above expressed were reached upon consideration of this matter in a wakeful hour of last night, and that I announced to counsel for Complainant before coming to this room this morning my desire to qualify my previous answers above mentioned, as I have here done.

R. D. Q. 67. In your opinion, then, would a method of repair of asphalt pavements, otherwise the same as the method described in the Perkins method patent here sued upon and claimed in claim 1 thereof, but in which a dope of thin, hot asphalt, as referred to by you in your last answer, is interposed between the hot new material and the hot old material, but without in fact preventing an intermixture and union between the new and old mate-
83 rial materially differ, in fact, from the method of claim 1 of the Perkins method patent here in suit?

A. In my opinion it would not.

R. D. Q. 68. What is your opinion as to whether, as a matter of fact, any ordinary brush coat of hot liquid tar, or hot melted asphalt, applied between the heated and softened edges of a spot of asphalt pavement to be repaired and new hot asphalt composition applied to such spot for the purpose of repair, would actually prevent the intermixture and union between the old and new asphalt composition, as contemplated by the Perkins method patent in suit?

A. Such a coating as would be applied by a brush, if the asphalt of tar were highly heated and therefore thin, would practically cease to be a coating by reason of its absorption, and, in my judgment, would not defeat, or be inconsistent with, the

method set forth in the Perkins method patent in suit and claimed in the first claim thereof, the old material about the repair being in a hot and soft condition and the juncture of old and new material being operated upon by a hot tamping and smoothing iron, as referred to in the patent.

R. D. Q. 69. What do you say as to whether the avoidance of the Perkins method patent here in suit in the practice of a method in which a dope or solder between the old and new materials is used, but which is otherwise the same as the method of the Perkins patent, depends upon the question of fact as to whether the dope actually used or the conditions under which it was applied are such as to actually prevent a union and intermixture of the old and new materials?

A. I think it depends altogether upon the question of fact
84 as to the character of the union between the old and new pavement compositions. I regard integrity of the old and new materials as a primary requisite of the Perkins invention, and if this result be attained by the use of the steps enumerated in the claim in suit, I think that the useless insertion of a thin, hot, asphalt paint which would be dissipated and would not prevent the substantial union and continuity of the new and old material, would not constitute an avoidance of the patent and claim in suit.

R. D. Q. 70. What do you understand was the purpose served by the heat "sometimes" used in the prior art as referred to in the specifications of the method patent here in suit?

A. In the repair of asphalt pavements by the old method, it was customary to chop out the defective part to the bottom of the asphalt layer. Sometimes, and especially in cold weather, this asphalt layer became hard and brittle, so that, in striking it with an axe, to make the boundary of the hole, it would crack and break. Moreover, it would be quite difficult to penetrate with the mattock in forming this circumscribed line of the proposed excavation and correspondingly difficult to be cut out by the pick within that line. The heating referred to in the patent as having been "sometimes" applied "to the spot to soften the "material so that it may be more easily removed" was, as I understand it, such a heat as would merely render the material more easily penetrable by the axe and pick, and not at all such a heating as would give to the material at and around the spot the softness which it possessed when originally laid, or suitable to direct union with new materials.

85 R. D. Q. 71. Did such heating as was practiced in the prior art serve to facilitate the cementing or attaching of the patch or new material to the pavement being repaired?

A. I do not understand that it ever did.

R. D. Q. 72. What do you say as to the terms of claim 1 of the Perkins method patent here in suit on their face, covering any method of repairing asphalt pavement by the addition of new asphalt composition, in which a heating of the pavement to be repaired is utilized to facilitate or bring about a perfect union between the new and old material?

A. It does not do it. The claim specifies a series of three steps of which only one step is the heating of the old pavement material, or the surface thereof, to a greater or less depth. Each of these steps is necessary to effect a compliance with the claim. But it is, I think, true that the claim covers any procedure which involves the steps specified and in which, by the heating of the old material where the new is to be joined with it, such joining is made a substantially integral union of the old and new substances, the new material being understood to be hot at the time of its application.

R. D. Q. 73. Is or is it not true that by the use of the method of claim 1 of the Perkins patent herein sued upon, it is practical, in repairing asphalt pavements, to make what are known as "skim" patches or repairs; that is, repairs in the neighborhood of a half inch thick as compared with repairs in which the entire depth of the asphalt layer is dug out, and how does the Perkins method compare with the prior art in this respect, if you know?

A. I answer the first part of the question affirmatively.
86 Answering the second part of the question: The Perkins method differs wholly from the old art, as I understand it, in that such "skim" patching was not known in the earlier art.

Re-Cross Examination by Mr. Peirce.

R. X. Q. 74. Would the conditions of procedure set out by Perkins method patent No. 501,537, and defined in claim 1 thereof, be satisfied if no part of the old material were removed from the hole after being heated to properly soften such material, but were left in situ and were merely raked over to expose fresh surfaces preparatory to the adition of the new hot asphalt composition with subsequent treatment, as by said claim specified?

A. As I understand the question, it would.

MELVIN E. DAYTON.

Duly certified to by E. B. Sherman, Master.

Master's fees paid by Complainant, $83.80.

IN THE CIRCUIT COURT OF THE UNITED STATES,

FOR THE NORTHERN DISTRICT OF ILLINOIS.

United States Repair & Guaranty Company
vs.
Assyrian Asphalt Company et al.

In Chancery.
No. 24,534.

The parties met for the purpose of continuing the evidence for the Complainant, pursuant to the following notice, duly entitled herein:

"To Messrs. Peirce & Fisher,
Solicitors for Defendants:

Please take notice that on Thursday next, September 23rd, 1897, before Frank H. Drury, a Notary Public in and for the County of Cook, in the State of Illinois, we shall
87 proceed, at 2 o'clock p. m., to take the testimony of Henry R. Kasson, of 818 Wyandotte St., Kansas City, Missouri, in behalf of the Complainant, at Room 1515 Monadnock Block, Chicago, at which time and place you are invited to be present for the purpose of cross-examining the said witness and of examining exhibits to his deposition which may then be introduced in evidence.

Very respectfully,
RAYMOND & OMOHUNDRO,
Solicitors for Complainant.

Chicago, September 20th, 1897.

Service of the above notice accepted this 20th day of September, 1897.

PEIRCE & FISHER,
Solicitors for Defendants."

Present: Mr. George P. Fisher, Jr., of Peirce & Fisher, Solicitors for the Defendants, and Mr. James H. Raymond, of Raymond & Omohundro, Solicitors for the Complainant.

And thereupon the following proceeding were had:

Mr. HENRY R. KASSON, a witness produced on behalf of Complainant, having been first duly sworn, testified as follows:

Q. 75. What is your name, age, residence and occupation?

A. Henry R. Kasson; age 39; Kansas City, Mo.; District Superintendent of the Barber Asphalt Paving Company.

Q. Please state generally what the district referred to in your last answer covered?

A. It covers all the cities on the Missouri River and lying west of the river in which the Barber Asphalt Company operates.

88 Q. 77. Since what year have you been employed by or connected with the Barber Asphalt Paving Company?

A. Since 1888.

Q. 78. Since that date you have been continuously connected with that Company and generally informed as to its business being during all the succeeding years in charge of some part of this work, have you?

A. I have.

Q. 79. Please state whether or not since 1888 your occupation and experience have been such as to quality you to testify as to what has been done both in and outside of the district which you mentioned in the matter of repairing of asphalt pavements?

A. They have.

Q. 80. Please state whether, in the experience and employment referred to, you have heard of and considered anything known as "The Perkins Method" or "The Perkins Apparatus" for making repairs in asphalt pavements?

A. I have.

Q. 81. I am asking you questions which relate solely to the commercial conditions since 1888 of the repairs of asphalt pavements, without reference whatever to what patents may or may not have been issued. I wish now that you would, in your own way, make answers to two questions:

First. What, in the trade, has been recognized as the "Perkins Method," and the "Perkins Apparatus"; and

Second. What has been recognized in the trade, since 1888, by the terms "skim-patching" and "surface-heating?"

89 Counsel for defendants objects to the first of the foregoing questions as immaterial and irrelevant unless the identity of the so-called "Perkins Method" and "Perkins Apparatus" is first established with the method and apparatus set forth in the patents here in suit.

A. It has generally been understood in the trade since the introduction of the "Perkins Method" of the repairs of asphalt pavements that it meant the softening of the surface of the asphalt wearing coat to such a degree that a portion of the old surface could be removed by scraping or otherwise and a new surface raked and rolled in in order that the part repaired should conform with the contour of the surrounding pavement. By the "Perkins Apparatus," it has been generally understood in the trade since its invention that it applied to a machine or apparatus for producing the necessary heat to soften the surface of the asphalt wearing colt, in order that enough of the wearing surface could be removed by scraping or otherwise so that a fresh, clean surface could be had, in order that new material could be made to adhere to the surface so prepared.

The term "skim-patching" has been generally recognized in the trade as the removal of small defects in the new work as it was being laid, such as foot marks, roller marks, small low places, by removing small portions of the asphalt wearing surface by means of hot shovels, hot smoothers or any other means by which a small portion of the surface could be removed and fresh material used to make a new surface that would conform with the contour of the surrounding pavement or obliterate the foot marks or roller marks. The term "surface heating" has been always
90 understood in the trade to relate solely to the "Perkins Method" of making repairs in asphalt pavements.

Q. 82. In all your experience, has there been, prior to your knowledge of the Perkins improvements, any application of heat in the repairing of an asphalt pavement, besides the "skim patching" to which you have referred, which either covered or made ready the spot to be repaired, both as to horizontal lines and to vertical lines, or either or both of them?

Counsel for Defendant objects to the foregoing question as indefinite, in that it is not made plain whether the "Perkins improvements" therein referred to have relation to the patented inventions in the suit or not.

A. The only other means of which I have knowledge was the covering of small places or defects to be repaired with hot sand.

Q. 83. Now I will ask you whether or not in all your experience and knowledge about this art since 1888 the application of heat by what you have come to know in the trade as the "Perkins Method" and the "Perkins Apparatus" has obviated the use of picks and axes or any other tool which related to the methods

previously employed. Please answer this question in your own way and give any facts which may be within your own knowledge for any part of the answer you may make.

Counsel for Defendants objects to the question as immaterial and irrelevant in that the identity of the "Method" and "Apparatus" therein referred to with the method and apparatus defined by the claims of the patents in suit has not been established.

A. The use of the "Perkins Method" of repairing asphalt
91 pavements has obviated to a very large extent the necessity of cutting out or removing the surface by means of picks, axes or other tools. Prior to the use of the "Perkins Method" repairs to asphalt pavements were entirely made by the cutting out and removing of the entire asphalt wearing surface to the concrete.

Q. 84. Prior to the disclosure of what you say has come to be known in the trade as the "Perkins Method" and the "Perkins Apparatus," was there, so far as your knowledge and experience goes, any method or practice which, by heat, would reduce the part to be removed into a state for removal clear down to the foundation upon which it was originally put?

Same objection.

A. There was not.

Q. 85. You may please state from such knowledge as you have, whether or not your Company, the Barber Asphalt Paving Co., has in any way acknowledged or acquiesced in what we have called the "Perkins improvements" and more especially referred to as the "Perkins Method" and the "Perkins Apparatus"?

Same objection.

A. I have been notified by the proper officials of my Company that they had acquired, by license, the right to use the "Perkins Method" and the "Perkins Apparatus" for making repairs in asphalt pavements.

Q. 86. Referring especially to the words "acknowledged or acquiesced" in my last question, please state whether in any way you were a party to any investigation by the Barber Asphalt Paving Co. of the "Perkins Method and Apparatuses" before
92 the license rights were acquired, to which you refer, and please state what the result of that investigation was?

Counsel for Defendant objects to the questions as immaterial and irrelevant.

A. By directions of the general officers of my Company I investigated as to whether there were any means by which heat

had ever been successfully applied for preparing asphalt wearing surfaces for repairs. I found that previous to the introduction of the "Perkins Method" no means had ever been found by which heat could be used for the preparing of the asphalt wearing surface for repairs in a general and economical manner. The only methods for applying heat that I could discover before the use of the "Perkins Method" were those that I have already testified to regarding the making of small repairs in new work by the use of hot shovels, hot smoothers or hot sand, all of which were extremely satisfactory and very expensive.

Solicitor for Complainant proffers in evidence an original copy of a contract between the Barber Asphalt Paving Co. and the City of St. Joseph, Mo., made and entered into September 9th, 1897, the same covering the repairs for asphalt pavements in said city for the period of five years from the date thereof.

Thereupon it was agreed and stipulated by the solicitors for the respective parties that the following copy thereof is a true, full and correct copy of the original, to wit:

93 ARTICLE OF AGREEMENT BETWEEN THE BARBER ASPHALT PAVING COMPANY AND THE CITY OF ST. JOSEPH, MO.

This agreement made and entered into this ninth day of September, 1897, by and between the Barber Asphalt Paving Company, a corporation duly organized and existing under and by virtue of the laws of the State of West Virginia, party of the first part, and the City of St. Joseph, a municipal corporation organized and existing under and by virtue of the laws of the State of Missouri, party of the second part.

Witnesseth: That said party of the first part for and in consideration of the covenants and agreements of said party of the second part hereinafter contained, hereby covenants, promises and agrees to and with said party of the second part that it, said party of the first part, shall and will furnish all materials and perform all the work necessary to repair in a good, substantial and workmanlike manner for a term of five years from and after the first day of October, 1897, all the asphalt pavements on the streets in the City of St. Joseph, excepting the parts of such asphalt pavements as are required to be kept in repair by the Street Railway Companies, operating their lines in said city, in compliance with the following

SPECIFICATIONS:

KINDS OF REPAIR.

The general repairs as to the wearing surface will be of two kinds. 1st. When it is necessary to cut out the asphalt to the concrete. 2nd. Skimming.

94 ### EXTENT OF REPAIRS.

The repair of wearing surface and concrete base shall be made at such times and to such an extent as is directed by the City Engineer or his representatives.

And all defects such as ruts, cracks, depressions, holes, etc., will be considered as repairs under this contract and shall be remedied and repaired as directed by the City Engineer or his representatives; and any asphalt pavements taken up for sewers, water or gas service, or any underground structure, shall be replaced and repaired by the said party of the first part at the time and in the manner directed by the City Engineer, the costs of such work to be paid by the party taking up the pavement.

CONCRETE.

When it is necessary to replace the concrete base, the base thus replaced must be six inches in thickness and composed of one (1) part hydraulic cement, two (2) parts sand and five (5) parts broken stone. The sand and cement to be thoroughly mixed dry and then water shall be added in sufficient amount to make a stiff mortar. Broken stone then added to the mortar and the whole thoroughly mixed by means of hose or shovels.

BINDER.

The second or binder course shall be placed on a concrete base and consist of a concrete made of clean, broken stone or gravel, but not exceeding one and one half (1 1-2) inches in the largest dimension, thoroughly screened, and coal tar resid-
95 uum, commonly known as No. 4 Paving Composition, or its equivalent of asphaltic cement; the gravel or stone will be heated and then thoroughly mixed with the Paving Composition

in the proportion of one gallon of paving composition or asphaltic cement to one cubic foot of stone. The binder will be hauled to the work while hot, carefully spread on the base with hot iron rakes to such a depth that the least thickness for the top or wearing surface will be one and one-fourth (1 1-4) inches when the sum of the top and binder is not over two (2) inches. As this sum increases the thickness of the top will be increased until it contains a depth of two (2) inches. Beyond this the thickness of the binder will be increased to make up the required thickness.

PAVEMENT PROPER.

Upon the binder course shall be laid the pavement proper in accordance with the requirements given below.

WORKMANSHIP.

All repairs to the asphalt surface must be made with the same kind of asphalt as the pavement and laid so as to bring the surface even with the adjoining pavement, making a close, smooth joint therewith and to conform to the contour of the pavement. The old pavement to be cut so as to make a beveled joint of the old and new material and all joints are to be painted with pure hot asphalt before the new material is laid.

SKIMMING.

Skimming will be done to the extent directed by the City Engineer. The contractor will heat the asphalt by means of a heater made for the purpose so as to be able to scrape off
96 the defective surface to a depth sufficient to make the finished patch conform with the contour of the street.

OLD MATERIAL.

All old material, dirt, asphalt, concrete, etc., broken up, is to be the property of the contractor and is to be swept up and removed promptly from the street by him.

MEASUREMENTS.

Measurements will be made by a superficial measure as near as can be reduced to a straight line measurement and wherever any disagreement occurs as to the amount of repairs made, the measurement and determination thereof by the City Engineer shall be conclusive. The work actually done shall be paid for at the following prices per square yard:

1. For resurfacing, by which the entire asphalt surface is to be taken out to the concrete and is to include all work necessary except new concrete, per square yard.....$1.46

2. For skimming, where only part of the wearing surface is removed and replaced by new material, per square yard $0.98

3. For replacing the entire pavement, including concrete base, per square yard.....$2.12

Payments are to be made monthly for all work done during the preceding month.

In testimony whereof, the parties of the first and second parts have caused these articles of agreement to be signed in triplicate the day and year first above mentioned.

97

THE BARBER ASPHALT PAVING CO.,
By HENRY R. KASSON,
Its Attorney in fact.

CITY OF ST. JOSEPH, MO.,
By CHAS. O. CAMPBELL,
City Engineer thereof.

City of St. Joseph, Mo.,
9th 1897.

The foregoing contract is in due form according to law and is hereby approved.

B. J. CASTEEL,
City Counselor.

City of St. Joseph, Mo.,
September 9, 1897.

The foregoing contract, and bond attached, have been this day approved by the Common Council of the City of St. Joseph.

Attest: CHAS. S. SHEPHERD,
City Clerk.

Defendants' Solicitor objects to the introduction of the contract as immaterial and irrelevant.

Q. 87. Please state whether the said contract between your Company and the City of St. Joseph had any relation, and, if so, what relation, to the "Perkins Method" and the "Perkin Apparatus" that we have been talking about?

Same objection.

A. They did. The contract and specifications call for the use of the "Perkins Method" when directed by the City Engineer.

98 Q. 83. Can you say anything further to us as to the meaning in the trade and work of making and repairing asphalt pavements as to what the term "Surface-Heating" has meant since 1888?

A. Prior to the introduction of the "Perkins Method" the term "Surface-Heating" had no significance in the trade. After the introduction of the "Perkins Method," the term "Surface-Heating" has universally been used to designate the repairing of asphalt pavements by the "Perkins Method" and with the "Perkins Apparatus."

Q. 89. Please state whether you and your Company recognized any particular advantage in the application of the "Perkins Method and Apparatus," in the use of liquid asphalt, as distinguished from rock-asphalt, and give any facts which may be within your knowledge as to this matter?

Question objected to as the "Perkins Method and Apparatus" referred to are not identified with the specific method and apparatus defined in the claims of the patents in suit.

A. I believe the application of the "Perkins Method" has been particularly successful only in making r[illegible]rs to asphalt pavements in which liquid asphalt has been used in making the surface mixture. As far as my knowledge extends, and I believe it is so recognized by my Company, this method has not been a successful one in making repairs in what are known as "rock-asphalt pavements."

Q. 90. Has any other method or apparatus to this day known been successful in pavements made with "rock-asphalt," where the repair to be made should go beneath the skin and prac-

99 tically to the original foundation of the asphalt?

Same objection.

A. I know no method by which heat is used that has been successful to this day in making repairs to rock-asphalt pavement.

Adjourned to to-morrow, September 24th, 1897, at 10 o'clock a. m.

Friday, September 24th, 1897.

Met pursuant to adjournment.

Present: Mr. James H. Peirce, of Peirce & Fisher, Solicitors for the Defendants, and Mr. James H. Raymond, of Raymond & Omohundro, Solicitors for the Complainant.

Direct-Examination of Henry R. Kasson Continued.

Q. 91. Please state what you know as to the influence of the introduction of the "Perkins Method" and of the "Perkins Apparatus" upon the making of "repair contracts" or contracts involving repairs of asphalt pavements; and in answering this question you may also specifically state what you know, first, as to the recognition of the "Perkins Method and Apparatus" by municipalities and, second, whether contractors have been financially benefitted thereby?

A. Previous to the introduction of the "Perkins Method" it was necessary in making any repairs in asphalt pavements to cut through the asphalt wearing surface to the concrete or foundation and remove the wearing surface at the point where the repair was to be made. This was at all times a very expensive operation and since the introduction of the "Perkins Method" it has obviated this mode of procedure to a very great extent. So far as my knowledge extends, the "Perkins Method" of repairing asphalt pavements is generally recognized by municipalities in making contracts for maintaining asphalt pavements. I cite in particular the City of St. Joseph, Mo., which city has recently entered into a contract with the Barber Asphalt Paving Co. to maintain asphalt pavements in that city for a period of five years from September 9th, 1897. In this contract the "Perkins Method" of making repairs to asphalt pavements is distinctly recognized, inasmuch as the contract and specifications call for the making of repairs both by the old method of cutting the asphalt wearing surface through to the foundation and by the "Surface-Heating" or "Skimming" method which trade words are generally understood to distinctly mean the repairing of asphalt pavements by the "Perkins Method and Apparatus." In the St. Joseph contract a difference is made in the price between the two methods, that is it is provided that where the pavement is repaired by the old method of cutting through to the foundation, the price to be charged is $1.46 per square yard for surface repaired. Where the repair is made by

the "Surface-Heating" or "Skimming," or, in other words, the "Perkins Method," the price to be charged is 98c per square yard of surface repaired.

To my knowledge a similar contract to that now existing in St. Joseph is in existence at Buffalo, New York, and a similar one is now pending in the City of Wichita, Kas.

I can state that to my knowledge both municipalities and contractors have been benefited financially by the introduction of the "Perkins Method and Apparatus" for making repairs to as-
101 phalt pavements, but I believe the principal financial gain has been that to municipalities, as by the use of this method more extensive repairs can be made than under the old method at a large saving of cost.

Cross-Examination by Mr. Peirce.

X. Q. 92. How long have you been practically familiar with the method of laying asphalt pavements?

A. Since 1888.

X. Q. 93. Please describe what the general method is for laying asphalt pavements since you were practically familiar therewith, stating in detail the mode of procedure, the thickness of the several layers and the materials or composition employed.

Question is objected to as indefinite.

A. The earth foundation or grade is first excavated to the depth of the required pavement or rather to the required depth of the pavement. This depth varies with the different thicknesses of the pavement to be laid. The grade after it has been excavated to the proper depth is compacted, generally by the use of steam rollers. Upon the grade thus prepared is laid a base or foundation, generally of concrete, which is composed of broken stone, sand and cement, wet down by means of water, thoroughly mixed, and after being deposited in place thoroughly impacted by means of hand tampers. The thickness of the base or foundation varies in different styles of pavements from four to eight inches. On the base so prepared is laid in one style of pavement a so-called "cushion-coat" generally one-half inch
102 thick, the mixture of which is composed of sand and asphalt cement. In the other style of pavement, the first coat spread upon the foundation is what is known as a "binder" coat, generally of a thickness from one to one and one-half inches. The composition of this coat is made up of fine broken stone first heated and then coated with asphalt cement. Both the "binder" and

"cushion" coats, after being raked out on the foundation, are compacted by means of tamping, hand and steam rolling. On the final coat in both classes of pavements is what is known as the "asphalt wearing surface," which is composed of a mixture of sand, carbonate of lime and asphalt cement. This asphalt cement is prepared by mixing refined asphalt with residuum oil. This mixture is brought to the street at a temperature ranging from 250 to 300 degrees of heat Fahrenheit, and is spread on the street by means of hot iron rakes, and is thoroughly compressed by means of tamping, hand and steam rolling to the required depth, which ranges in different classes of pavements from one to two inches in thickness when thoroughly compressed. There are other methods of preparing the foundation course other than I have already described, such as broken stone compressed by steam rolling to the required depth, after which the stone is coated with paving composition or asphaltic cement. On the wearing surface after it has been compressed by means of a hand roller a small quantity of hydraulic cement is swept after which the surface receives its final compression by means of the steam roller.

X. Q. 94. In making up the asphalt composition wearing surface, about what is the general proportion of the several ingredients used?

103 A. 70 to 80 per cent of sand, 15 to 5 per cent of carbonate of lime, I should have said 73 per cent of sand instead of 70 per cent—and 12 to 15 per cent of asphalt cement.

X. Q. 95. What is the "refined asphalt" which constitutes an ingredient of the so-called "asphalt cement"; also what is the "hydraulic cement" used as a top finish?

A. Refined asphalt is the product that remains after the impurities and moisture has been expelled from the crude asphalt by means of heat. Hydraulic cement is the product of cement rock after the CO_2 has been expelled by means of burning the rock, after which burning the rock is ground to a fine powder.

X. Q. 96. What is the crude asphalt from which the refined asphalt is derived; where is it obtained and how is it treated to extract the refined asphalt?

A. My answer to this question, or the first part of this question, will relate to Trinidad asphalt. Trinidad Lake asphalt is obtained in the Island of Trinidad, B. W. I. It is in the form of a so-called "lake" and is obtained by digging out the crude material with picks. Its chemical composition, so far as my knowledge extends, is 56 per cent bitumen and 44 per cent of mineral

matter, organic and inorganic. After the crude asphalt is dug from the place of deposit, it is brought to the refineries, where it is refined by two methods; first, by means of so-called fire refining, in which the crude asphalt is subjected to heat obtained by burning of coal, wood, etc., in which method the asphalt is subjected to about 340 degrees Fahrenheit for about 90 to 100 hours. During this time the moisture is driven off by the action of the heat and the other impurities contained in the crude are gotten rid of by either skimming the surface or sinking to
104 the bottom of the tank from which they are removed after the refined asphalt is drawn off. After the material has been subjected to heat for the proper length of time, it is drawn off and run into barrels where it is allowed to cool. The second process referred to is what is known as steam refining, which process is substantially the same as the first except that the heat is applied by means of passing steam through coils of iron pipe in the refining tank. The heat generated by this process runs about 325 degrees of Fahrenheit and the time required for refining the crude is from ten to twenty hours. I should have stated that the crude asphalt is composed of about 56 per cent bitumen and 44 per cent of mineral, organic and inorganic matter.

X. Q. 97. When the refined asphalt referred to is allowed to cool in barrels, does it become solid or remain liquid when cold?

A. It becomes solid when cold.

X. Q. 98. Are you perfectly familiar with the use of any other refined asphalt for street paving than that derived from crude Trinidad Lake deposit?

A. I am only practically familiar with the use of Bermudez asphalt besides the Trinidad.

X. Q. 99. What is the nature of this Bermudez asphalt which you refer to?

A. It contains a much higher percentage of bitumen than the Trinidad.

X. Q. 100. How does the Bermudez crude asphalt exist in natural deposits?

A. Somewhat similar to that of Trinidad.

105 X. Q. 101. In obtaining the refined asphalt from the crude material, how does the treatment of the Bermudez material differ, if at all, from the treatment you have detailed for refining the Trinidad?

The question is objected to by the solicitor for the Complainant as not at all relevant, either to the direct examination or to any issue in this case. Solicitor for Complainant does not want to interrupt or interfere with the right of

cross-examination and instructs the witness that he may answer this question, but he holds this objection as against a scattering cross-examination which shall not be directly relative to the direct examination or some issue of the cause to which this witness has already testified.

A. On this point I have no positive knowledge, but I believe the treatment of both materials in refining are very similar.

X. Q. 102. As the Bermudez refined asphalt comes upon the market in this country, is it solid in barrels like the Trinidad?

Solicitor for Complainant objects to this question, as relating purely to commercial conditions having no reference either to the issues of this cause or to the direct examination of the witness. The question, of course, will be answered by the witness, subject to this objection.

A. So far as my knowledge goes, it is.

X. Q. 103. In preparing the "asphalt wearing surface" for a street pavement, what difference in practice, if any, is ob-
106 served, to your knowledge, when the refined Bermudez asphalt is used in lieu of the refined Trinidad?

Same objection.

A. When Bermudez asphalt is used, owing to the fact that it contains a much higher percentage of bitumen and an almost total absence of mineral matter, it becomes necessary to use a smaller percentage of asphalt cement and a higher percentage of carbonate of lime.

X. Q. 104. What distinction do you observe in the use of the terms "refined asphalt" and "asphalt cement"?

A. By "refined asphalt" I meant the asphalt after it has been refined from the crude. By "asphalt cement" I mean the product of the mixing of refined asphalt and residuum oil in definite proportions.

X. Q. 105. In about what proportions are the refined asphalt and the residuum oil mixed to constitute "asphalt cement"?

A. In about the proportions of 100 lbs. of refined asphalt to from 17 to 20 lbs. of residuum oil.

X. Q. 106. What is this "residuum oil" to which you refer?

A. It is a product of crude petroleum after certain of the lighter oils have been distilled off.

X. Q. 107. Aside from Bermudez refined asphalt and Trinidad refined asphalt, are you practically familiar with the use of any other refined asphalt in connection with pavement laying?

The same objection is repeated and the further objection is made that, without any relation whatever to the direct

107 examination of this witness or to any issue in this case or to his qualifications as a witness, stated at the commencement of his direct examination, he is called upon to testify as to his practical experience in making, laying or repairing pavements. Of course, the witness should, subject to this objection, make such answer as he chooses. Let the question be read.

Question read.

A. I am not practically familiar with the use of other asphalts.

X. Q. 108. Are you practically familiar with the use of "rock asphalt" in pavement laying?

Same objection, as last noted.

A. Only to a very slight extent.

Recess.

2 o'clock p. m.

Testimony resumed.

Parties present as before.

X. Q. 109. What is this "rock-asphalt" about which question was made just prior to the recess?

Same objection.

A. Rock-asphalt, as I understand it, is limestone rock that has been impregnated with bitumen by nature's process.

X. Q. 110. Where was the "rock-asphalt" used about which you are familiar?

Mr. Raymond: Please make your question more definite and make it more definitely related to some testimony in this case.

108 Mr. Pierce: Mr. Witness, do you understand my question?

Witness: I think I do.

Mr. Raymond: Then please answer it with reference to anything which you have intended to testify about.

A. Kansas City, Mo.

X. Q. 111. Any other place?

Same objection.

A. No, sir.

X. Q. 112. From whence was the "rock-asphalt" obtained that was used in Kansas City, as you mentioned?

Same objection.

A. From Indian Territory.

X. Q. 113. To what extent and for for what purpose was such Indian Territory "rock-asphalt" used?

Same objection.

A. To what extent I am unable to state. It was used in making a mixture for laying somewheres between 20,000 to 30,000 square yards of pavement in Kansas City.

X. Q. 114. Can you give us an idea of the nature and composition of this mixture you refer to in which the "rock-asphalt" entered as an ingredient?

Solicitor for complainant repeats the last noted objection and further objects for that the inquiry now started upon is entirely aliunde to any issue in this cause and to any evidence yet given for the Complainant, either by this witness or by the preceding witness, Mr. Dayton.

109 A. I should have stated before that there is also what is known as sand-rock asphalt, which is, as I understand it, sand rock impregnated with bitumen by nature's process. I cannot state to its full extent the nature of the mixture or the ingredients that went to maket it up, that were used in the laying of the so-called rock-pavements in Kansas City. In general my knowledge of this mixture is confined to the fact that the sand-rock and lime-rock asphalts were ground, heated and mixed in certain proportions, but the definite percentage of these proportions I am unable to state.

X. Q. 115. How long ago was it that such "rock-asphalt" pavements were laid in Kansas City?

A. Part of these pavements were laid in the fall of 1896, and the balance during the spring and early summer of 1897.

X. Q. 116. In the practice of the so-called "Perkins Process," as known to you, is it necessary that the heat should be applied until the full depth of the upper or asphalt composition layer is softened?

A. It is not necessary.

X. Q. 117. In such practice, what determines the extent to which the softening is conducted in vertical depth of the layer?

A. The nature of the repair to be made. When using the "Perkins Method" it is only necessary to soften enough of the wearing surface so that enough may be removed that when the new surface is put in it shall conform to the contour of the surrounding pavement.

110 X. Q. 118. Is it necessary in the practice of such "Perkins Method" that any part of the softened old material shall be removed or taken out of the hole?

A. It is necessary that enough of the old softened material

be removed in order that a fresh, clean surface may be presented to receive the new material.

X. Q. 119. What is there about the old material which prevents it from presenting the fresh surface respecting which you speak?

A. The upper surface of the wearing coat, which is the material softened, always contains the dirt and hydraulic cement, for which cause it would be impossible to make a fresh surface unite with it in a homogeneous manner?

X. Q. 120. Is this so-called "Perkins Process" applicable for the repair of pavements irrespective of the kind of asphalt employed in making up the upper composition laver?

A. So far as my knowledge extends, this method is not successful where used on pavements laid solely with rock-asphalt.

X. Q. 121. With the exception of the "rock-asphalt" pavements, is the "Perkins Method" applicable for repairing pavements irrespective of the kind of asphalt present in the upper composition layer?

A. It is so far as my knowledge extends.

X. Q. 122. Have you ever seen the attempt made to repair "rock-asphalt" pavements according to the "Perkins Method"?

A. Only in a very small manner.

111 X. Q. 123. Will you please give us the particulars of this attempt, as known to you?

Both of the objections hertofore noted are here repeated, by consent, without being specifically named.

A. I made an attempt in Kansas City in the nature of an experiment to make a small repair on a piece of so-called "rock-asphalt" pavement by the "Perkins Method," in the spring of 1897. I was unable to make the two surfaces unite, this being especially the case at the joints.

X. Q. 124. I wish you would tell more fully just what the procedure was in making such experimental patch; tell us how you heated the spot, what amount of material you scraped off, what the nature of the material was which you filled in and how the patch was finished?

Both of the above objections are here repeated, by consent, without being specifically named, and the further objection is made that this question and the matter inquired about is utterly irrelevant.

A. We selected a small place in one of the pavements in Kansas City, made with so-called "rock-asphalt," softened the surface with a "Perkins Surface Heater," raked off the softened surface to the depth of about three-quarters of an inch, made

clean cut joints, painted these joints with asphalt cement, took a small piece of mixture that had been removed from a cut in this pavement, heated it until it would powder, raked this powdered product into the place where the surface had been removed, 112 thoroughly tamped it and smoothed and endeavored to unite the edges by means of a hot iron smoother.

X. Q. 125. Could a charcoal or coke brazier fire be used in the "Perkins Method" to soften the surface of the cavity preliminary to making the repair?

Mr. Raymond: Please make your questions a little more definite, as to whether it refers to the repair just talked about by the witness or to some other, and if another, what kind of a repair.

Mr. Peirce: Mr. Witness, did you understand my question?

Witness: I understand it to mean whether heat can be applied by the use of a charcoal or coke brazier for the purpose of softening the asphalt surface of the pavement to be repaired.

Mr. Peirce: That is correct; the pavement to be repaired according to the "Perkins Method." With this understanding kindly proceed to answer my question.

A. It could be used only to a limited extent, as it would take so long to soften the wearing surface sufficiently that it would be practically too expensive to use.

X. Q. 126. Prior to the advent of the "Perkins Method," you speak of minor repairs being made by the use of hot shovels, smoothers or hot sand. In what way were these several means employed for the purpose?

A. It was often the case that in laying new work small depressions and similar defects would be found in the finished 113 surface. In order that these defects could be quickly remedied, either a small portion of the surface was cut out by means of a heated shovel or softening the spot by means of a hot smoother or by placing hot sand over the spot, in order that a small portion of the surface might be sufficiently softened so that it could be easily removed and replaced with a fresh surface, making the contour conform with that of the surrounding pavement.

Re-direct Examination by Mr. Raymond.

R. D. Q. 127. Have you at any time personally planned, directed and superintended the laying of any pavement in which the asphalt used was exclusively either "rock-asphalt" or "Bermudez-asphalt"? I mean by this question to cover the laying

and completing of a pavement which you have planned, directed and superintended.

A. No, sir; as far as it extends to "rock-asphalt" pavement. My experience in laying asphalt pavements made exclusively with "Bermudez-asphalt" has been where this work was done in buildings.

HENRY R. KASSON.

Here follows a certificate in due form, and under his official seal, by Frank H. Drury, as a notary public in and for Cook County, in the State of Illinois, covering the foregoing deposition of Henry R. Kasson.

Notary's fees paid by complainant, $21.85.

114 IN THE CIRCUIT COURT OF THE UNITED STATES

FOR THE NORTHERN DISTRICT OF

ILLINOIS, NORTHERN DIVISION.

United States Repair & Guaranty Company
vs.
Assyrian Asphalt Company et al. } Gen. No. 24,534.

Washington, D. C., October 4, 1897.

The parties met by agreement, for the purpose of continuing complainant's prima facie proofs, before Mr. J. Fred. Kelley, a Notary Public in and for the District of Columbia, this day at 11 a. m.

There were present, Mr. James H. Raymond, one of the solicitors for the complainant, Mr. James H. Pierce, one of the solicitors for the defendants, and the witnesses named below.

And thereupon the following proceedings were had:

MR. WILLIAM Y. WARREN, a witness produced on behalf of the complainant, having been first duly sworn, testified as follows:

Q. 128. Please state your name, age, residence and occupation?

A. William Y. Warren; 52 years; residence, Buffalo, N. Y. Cashier for the Barber Asphalt Paving Company, Buffalo, New York.

Q. 129. How long have you been connected with that company?

A. Since 1888.

115 Q. 130. Have you since that year been generally familiar with the methods and apparatuses used in repairing asphalt pavements?

A. I have.

Q. 131. Your company has in recent years done work which had some relation to what had been done by a man by the name of Amos H. Perkins, in repairing asphalt pavements?

A. Yes.

Q. 132. Please state, in your own way, what you know about the origin and significance of the following terms: "Skimming," "surface-heating," "Perkins' method," and "Perkins' apparatus"?

A. The term "skimming" as applied to repairs of asphalt pavements has come to mean the heating of the surface with proper apparatus, allowing the heated portion to be scraped off with hoes or other proper tools to a proper depth to allow the placing of new material in the space thus cleared out; of sufficient quantity to make surface of the street, after it is smoothed, tamped and compressed with rollers, conform to the contour of the surrounding pavement. "Surface heating" is practically a synonomous term, indicating the method of repairing defects in asphalt pavements, practically as stated above. "Perkins' method" is the same process of repairing pavements called "Perkins' process" from the fact that it was first used by Mr. Perkins, of Chicago. The "Perkins' apparatus" is a heater which can apply the heat necessary to soften the pavements where repairs are needed to permit the removal of the defective parts and repair the pavement by making a fresh surface for the placing of the new material to make the repair.

116 Q. 133. Has what you refer to in your last answer had anything to do, and if so, what, with avoiding the necessity for using picks, axes, or similar tools in the repairing of asphalt pavements?

A. Previous to the use of this method of skimming it was necessary to cut out with axes any defects which were to be repaired in an asphalt pavement from the surface to the concrete base, taking out all the defective wearing surface and replacing with new material. This was a tedious and expensive process, and the use of the skimming process has removed the necessity for chopping out the pavement, as in the skimming process only enough of the surface is removed to get a fresh surface upon which to place the new material.

O. 134. Please state whether or not by what you have referred to in your last answer as the "skimming process" any desired amount of bad or dead material can be removed?

A. Certainly, any amount of defective material can be removed in this way.

Cross-Examination by Mr. Peirce.

X. Q. 135. How long is it since you were first practically familiar with the mode of laying fresh or new asphalt pavements?

A. Since 1888.

X. Q. 136. In laying such pavements when the job was left incomplete at night, and the men began their work anew on the day following what precaution, if any, was observed in effecting a secure joint at the junction between the pavement already laid and the material just about to be applied next thereto?

117 A. My position as cashier gave me only a general knowledge of the business, and I could not state positively what precaution is taken in a case of this kind.

Mr. Pierce: I have no further examination of this witness to make.

WM. Y. WARREN.

Adjourned until 3 p. m.

3 p. m. Met pursuant to adjournment.

Parties present as before stated.

MR. J. H. CRANFORD, a witness produced on behalf of the complainant, having been first duly sworn, deposed and said.

Q. 137. What is your name, age, residence and occupation?

A. Joseph H. Cranford, age 27; Vice-President and Treasurer of the Cranford Paving Co.; residence, Washington, D. C.

Q. 138. Please state, in your own way, what you know about any Perkins method, system or apparatus in connection with the repair of asphalt pavements; and, in order, as briefly as possible to get the facts, I will ask you, in the second place, to state whether anything I have referred to in this question has been of financial benefit to municipalities and to contractors?

A. I should first say, that I first heard of the Perkins method of repairing pavements in the early part of the year 1894; the latter part of that year I saw the Perkins method in operation, and I was so much pleased with the results of the same that I

entered into a lease with the United States Guaranty and
118 Repair Co., to operate their machines and method. I have operated them since that time, and believe it to be a wonderful improvement over the old method of repairing asphalt pavements. Now, as to its financial benefits to municipalities and contractors would say that it is very much so, and in our city we find that there is a saving of about 33 1-3 per cent per superficial yard of pavement so repaired.

Q. 139. Has this saving which you have just referred to been recognized by any municipal or governmental officer, and if so, please state, generally, how it has been recognized?

A. It has been, by the Commissioners of the District of Columbia, and we have entered into a supplemental contract with them to repair the pavements with the Perkins method.

Q. 140. What do you understand by the "Perkins method," and you may, in answering this question, also state whether or not what you have referred to as the Perkins method has in any way obviated the use of axes, picks or similar tools?

A. By the Perkins method we use a machine made for the purpose of burning the old or worn out surface of an asphalt pavement which enables you to put a "skim" coating of new asphalt mixture over the burnt out part. This making a perfect repair and too unites the old with the new. Repairing in this way excludes the use of picks, axes, etc.

Q. 141. In this art was the word "skim" which you have just used, ever known or used, so far as your knowledge goes, until the advent of the Perkins method and apparatus?

A. Never with the intent of making a permanent or lasting repair.

119 Cross-Examination by Mr. Peirce.

X. Q. 142. How long is it that you have been practically familiar with the business of laying asphalt pavements?

A. Ten years.

X. Q. 143. How long is it since the Cranford Paving Co. was organized?

A. The Cranford Paving Co. was organized and incorporated in 1889.

X. Q. 144. With whom did you first engage in the business of laying asphalt pavements?

A. With the firm of Cranford & Filbert, of this city.

X. Q. 145. Did the Cranford Paving Company succeed to that firm?

A. Yes.

X. Q. 146. In what way, if any, is the Cranford Paving Company now affiliated with the Barber Asphalt Company?

A. We are in no way connected with the Barber Company.

X. Q. 147. Is the Cranford Paving Co. engaged in laying pavements elsewhere than at Washington, D. C.?

A. We lay asphalt pavements nowhere other than Washington, D. C., and vicinity.

X. Q. 148. From whom do you procure your asphalt supplies?

A. From the Barber Asphalt Paving Company.

X. Q. 149. In laying a new asphalt pavement, when the job is left incomplete at night and the men begin their work
120 anew on the day following, what precaution, if any, is observed in effecting a secure joint at the junction between the pavement already laid and the material just about to be applied next thereto?

A. On leaving the unfinished portion at night we cut a joint; when beginning at that point again we usually heat a little of the fresh or new material, and after leaving it a few minutes it is raked off to a true surface and tamped and rolled.

X. Q. 150. Is this hot new material piled over the edge of the joint you speak of?

A. It is.

X. Q. 151. What effect does such new material have upon this joint, as it lies plied thereon?

A. It has a tendency to slightly soften the joint, and enables you to make a smooth and tight joint.

X. Q. 152. Has that practice of heating the joint from day to day in laying a new pavement been in vogue ever since you first became familiar with the business of laying asphalt pavements?

A. It has not. We have ony done this recently.

X. Q. 153. What was the practice in such regard when you first became familiar with the business of laying asphalt pavement?

A. The custom used to be to paint the joint with asphalt cement.

X. Q. 154. Was this asphalt cement hot or cold?

A. It was applied as a liquid, and was hot, necessarily so.

X. Q. 155. Did you ever know the use of hot sand applied at the joint, in lieu of the hot fresh material, in order to soften
121 the laid pavement at the joint preliminary to the addition of new material in continuing the piece pavement?

A. Don't know that I ever have.

X. Q. 156. What was the old practice for repairing a spot which was in vogue prior to the advent of Perkins' method?

A. I never knew of repairs to be made prior to that time other than by means of picks and axes; cutting out the worn out piece and replacing the same with new material.

X. Q. 157. In this old method of repairing to what extent, in vertical depth, was the worn place cut out?

A. In most all cases to the full depth of the old asphalt pavement existing.

X. Q. 158. By which you mean that the binder layer, and the concrete layer were cut also?

A. No. The asphalt wearing surface and binder only.

X. Q. 159. After this stuff was cut out how did you proceed thereafter to complete the repair?

A. First by cutting the old edge smooth and perpendicular by means of an ax, after which painting the same with asphalt cement. A patch in this condition was ready for the reception for the binder and surface mixtures; after which it was finished by means of tampers and rollers, leaving the surface as near as was practical, level with the old pavement.

X. Q. 160. Is this old mode of procedure still resorted to by your Co. in making asphalt pavement repairs?

122 A. Rarely ever.

X. Q. 161. Does your contract with the District Commissioners at present existing call for the use of such mode of procedure?

A. Our present contract with the District Commissioners provides to repair pavements in both ways.

X. Q. 162. Have the district officers the option of designating which one of these ways is to be followed in making repairs?

A. They have.

X. Q. 163. What is the rate per square yard which now stands in the contract on making repairs by the two methods we have been discussing?

A. We do not make repairs here by the surface yard. Our contract reads with the Commissioners are by the cubical amount of material used.

X. Q. 164. On the basis of the cubical amount of material used, what is the rate stated by the present contract, for each repair contract we have specified?

A. By the old method of cutting out we are paid seven dollars and twenty cents a cubic yard for the binder material and $17.50 for the surface material. Under the Perkins method we are paid $20 a cubic yard; repairing the pavements by the Perkins method, there being no binder used, we have no price for this material.

Re-Direct Examination by Mr. Raymond.

R. D. Q. 165. You mean that when you use the Perkins method the binder may be left undisturbed?

A. I do.

123 R. D. Q. 166. In reply to cross-question 148, you said something about obtaining from the Barber Asphalt Paving Company asphalt supplies. That question and answer will be read to you, if you desire it. My question is as to whether you ever obtained from that company any apparatus which would permit of the use of the Perkins method we have been talking about, or did you merely mean by that answer that you have obtained from that company bituminous supplies?

A. The supplies we obtained from that company are only the crude and refined asphalt.

JOSEPH H. CRANFORD.

Adjourned until Tuesday, October 5, 1897, 2 p. m.

Washington, D. C., October 5, 1897.

The parties met pursuant to adjournment.

Present, as before stated.

MR. WILLIAM H. LOBER, a witness produced in behalf of complainant, having been first duly sworn, deposed and said as follows:

Q. 167. Please state your name, age, residence and occupation?

A. William H. Lober, age 42, General Superintendent of the Vulcanite Paving Company, of Philadelphia.

Q. 168. Since what date have you been familiar with methods and apparatuses for repairing asphalt pavement?

A. Since 1886.

Q. 169. Has your company recognized in any manner, 124 and if so in what manner, any method or apparatus for repairing asphalt pavements made by Amos H. Perkins?

A. The Vulcanite Paving Company have leased from the United States Repair and Guaranty Company the right to use the method known as the Perkins method of repairing asphalt pave-

ments; also of using five machines known as the Perkins Surface Heater to properly make repairs to asphalt pavements by that method.

Q. 170. What is that method, and how did it differ from what preceded it?

A. The Perkins method of repairing asphalt pavements is by the use of the Perkins Surface Heater to heat the surface of the asphalt sufficiently to remove the crust of the old pavement, also to sufficiently heat the pavement remaining, so that when a coat of new mixture is applied to it, a permanent repair will be made. By the old method it was necessary to use an ax, pick or some sharp instrument to cut out the top coat of the asphalt entirely down to the base, if a binder was used, through the binder as well, and entirely fill up the pavement displaced.

Q. 171. At what date, and where, within your own personal know'edge, was this first done?

A. I first saw repairs made by this method in the summer of 1893, on West Monroe street near Kedzie, in the City of Chicago.

Q. 172. Under whose direction or superintendence?

A. Amos H. Perkins.

Cross-Examination by Mr. Peirce.

X. Q. 173. How long have you been connected with the Vulcanite Paving Company?

125 A. About eighteen months.

X. Q. 174. State in detail, the names and addresses of the various parties with whom you have been connected since you first became familiar with the methods and apparatus for repairing asphalt pavements?

A. I was first connected with the Vulcanite and Barber Paving Company, of Philadelphia, Pennsylvania, in 1886; from 1886 until March, 1896, I was connected with the Barber Asphalt Paving Company, No. 1 Broadway, New York; from that time until the present, with the Vulcanite Paving Company, of Philadelphia.

X. Q. 175. What was the source of the asphalt supplies used by these several companies during the time you were with them, respectively?

A. The Vulcanite and Barber Company used asphalt from the asphalt lake on the island of Trinidad. The Barber company used asphalt from the same source. The Vulcanite company, during the last year, have used asphalt from Bermudez lake, Venezuela, South America; from the Bakersfield Deposit owned by Jewett & Blodgett, Bakersfield, California; Alcatraz asphalt, from the Alcatraz deposit, in the state of California; the Neuchatel asphalt

from the Neuchatel Asphalt Company; Sicilian asphalt; Trinidad lake asphalt; and other rock asphalts and mastics.

X. Q. 176. Is this Perkins method, as defined by you, equally applicable in making pavement repairs where any of these asphalts named by you have been used in laying the original pavement?

A. With the exception of the rock asphalts, yes.

X. Q. 176. What in your experience leads you to except the rock asphalts from this category?

126 A. By failure to successfully make repairs by that method on pavements laid with rock asphalt.

X. Q. 177. What sort of rock asphalt were they upon which you thus failed?

A. Sicilian rock asphalt.

X. Q. 178. Did your company lay the Sicilian asphalt pavement upon which this repair failure occurred?

A. They did.

X. Q. 179. How many attempts to repair such Sicilian asphalt pavement—according to the Perkins method—did you make?

A. Three or four.

X. Q. 18 . How long after such pavements were first laid did you attempt to make these repairs?

A. About six years after they were originally laid.

X. Q. 181. In making these attempted repairs what sort of material did you employ as a fresh filler?

A. The first attempts were made with Sicilian rock asphalt; later attempts with Trinidad asphalt.

X. Q. 182. Did you experience the same sort of trouble as the result of each attempt?

A. The rock asphalt crumbled away almost immediately after traffic went over it; the Trinidad peeled off after a few days' wear.

X. Q. 183. From which I understand that the fresh filler of Sicilian rock asphalt crumbled away under the traffic, whereas the older portions of pavement embodying Sicilian rock asphalt withstood the traffic except for ordinary wear and tear; am I correct?

A. Yes.

127 X. Q. 184. To what do you attribute the difference in lack of durability between the new filler and the old pavement, in the particular noted?

A. The new filler did not adhere to the old pavement, consequently there was just a thin coating of Sicilian rock which had not sufficient body to withstand traffic.

X. Q. 185. Does it occur to you that this new filler of Sicilian

rock asphalt may have been overheated and thus lost its cohesion before it was dumped into the repair spot?

Objected to by Mr. Raymond, as not proper cross-examination.

A. It was not overheated.

X. Q. 185. What then is your idea as to the cause of the trouble?

A. The failure of the portion of new filler to adhere to the old pavement.

X. Q. 186. You have stated to me the result of the defect which seems to have been present in the new filler; what I wish to know—if you are aware—is the cause of the defect which led to the result you have specified? That is, I wish to know what inherent quality or lack of quality characterized the new filler and led to its crumbling?

A. In applying heat by the Perkins method to a Trinidad pavement the crust of a pavement is crumbled; when this is removed there is a perfectly fresh body of asphalt mixture upon which to apply your new material, and you get an absolute union between the new and the old. In my efforts to repair Sicilian rock asphalt pavement the heat seemed to shrivel and dry up
128 all the bitumen in the pavement, and when the crust was taken off as in repairs of Trinidad pavement, it was found so dry that it was impossible to make the new material adhere to the old.

X. Q. 187. What in your judgment was the cause which led the new Trinidad filler to peel off after a few days' wear, as you have stated?

A. Practically the same cause that made a failure of the rock filler.

X. Q. 188. Was the quality of the Sicilian rock asphalt used by you as a filler in making said repairs such as you would have employed in laying an entirely new pavement where you were under heavy bonds to have the pavement last for five years at your cost for its repairs.

Mr. Raymond: The question is objected to as not proper cross-examination, irrelevant and immaterial.

A. It was.

X. Q. 189. Who was it that laid the original Sicilian rock asphalt pavement upon which you attempt to make the repairs as stated?

A. The Vulcanite Paving Company, of Philadelphia.

X. Q. 190. Were you employed by said company at the time such original pavement was laid?

A. I was not.

X. Q. 191. Does your company at present recommend the use of Sicilian rock asphalt for pavements?

Mr. Raymond: The present inquiry is as to the state of the art in or about the year 1893. Each of the objections above noted are here repeated, but by consent not in detail.

A. The Vulcanite Paving Company in the course of their
129 business lay all kinds of pavements that may be advertised for; they do not specially recommend any particular pavement; they lay brick, rock asphalt, Trinidad asphalt, or anything else that may be called for.

X. Q. 192. With which is you company most familiar in laying pavements; the use of rock asphalt or the use of Trinidad Lake asphalt?

A. The specifications of the City of Philadelphia, in which the Vulcanite Paving Company are doing business, have generally called for Pitch Lake asphalt, though quite a number of rock asphalt streets have been laid, some of which have been laid by the Vulcanite Paving Company.

X. Q. 193. With which material are you most familiar in laying pavements; the use of rock asphalt or the use of Pitch Lake asphalt?

A. The use of Pitch Lake asphalt.

X. Q. 194. Are the temperatures observed in laying these two sorts of asphalt material the same for each?

A. No.

X. Q. 195. Give the range of temperature observed in laying the Sicilian rock asphalt and the Pitch Lake asphalt, respectively?

Mr. Raymond: Please make your question more definite as to time, place and condition.

Mr. Peirce: Mr. Witness, do you understand my question?

The Witness: Yes, I can answer that question; it seems to have but one meaning.

Mr. Peirce: Please proceed with your answer.

A. The Sicilian rock asphalt should be laid at a temperature of not exceeding 250 deg. F. Pitch Lake asphalt is laid at a temperature ranging from 270 to 300 deg.

130 X. Q. 196. In laying a new asphalt pavement, when the job is left incomplete at night and the men begin their work anew on the day following what precaution, if any, is observed, in effecting a secure joint at the junction between the pavement already laid and the fresh filler just about to be applied next thereto?

Mr. Raymond: Same objections.

A. There are several ways of making joints. The best joint is made by the Perkins Surface Heater, making a sloping joint; joints are sometimes made by just cutting the edge roughly with an ax, and piling the hot mixture along the edge until it can be softened and broken down, thus making a union of the two parts.

X. Q. 197. This mode of joining wherein the hot material is piled over the cut edge of the pavement already laid, how long has it been practiced to your knowledge?

A. Ever since I have been in the business.

W. H. LOBER.

Adjourned until October 6, 1897, at 10:30 a. m.

Washington, D. C., October 6, 1897.

Parties met pursuant to adjournment.

Present as before.

HENRY N. MOSS, a witness produced on behalf of complainant, having first been duly sworn, deposed and said as follows:

Q. 198. Please state your name, age, residence and occupation.

A. Henry N. Moss, 53 years, Superintendent of streets, 131 District of Columbia, residence, Washington, D. C.

Q. 199. Since what date have you been familiar with methods and apparatus for repairing asphalt pavements?

A. August, 1883.

Q. 200. What have been your opportunities for observing the methods and apparatus used in asphalt pavements, and where has your experience occurred?

A. In the streets of Washington, D. C.; my duties as superintendent of streets covering the repairs of asphalt and other sheet pavements.

Q. 201. Do you know anything about any method of repairing asphalt pavements, other than the old method of chopping and cutting, which has been used, within your knowledge and experience, on the streets of Washington?

A. I do. The system known as the Perkins Heater system. My knowledge extends from the year the Barber Asphalt Paving Company brought it here to repair their guaranteed streets. To the best of my recollection the fall of 1894.

Q. 202. Please state in what particulars the Perkins system you have referred to differs from the old systems, describing generally, if you please what was done in repairing asphalt pavements before the Perkins' heater was brought into use here, and what was done by the use of Perkins' system?

A. In repairing under the old system it was necessary to cut out all wearing surface and binder down to the concrete base. In asphalt pavements on a bituminous base the material had to be removed down until we got a good foundation; this was done by pick and what is commonly known as an asphalt cutter.

132 The edges after being trimmed were painted with asphalt cement and the new material was placed in the part cut out, tamped on the edges and rolled with two rollers. Under the Perkins heater system the old or poor stuff is burnt out until the burning reaches good material, the depth of this burning under the present specifications was required to be at least three quarters of an inch; I have seen repairs made where the depth was less and the repairs were made in first class order. This burnt out material is then scraped out, and under the present District specification the surface must be reheated again before the asphalt that is used to make the repairs is put in. It is then rolled with a steam roller.

Q. 203. Please state whether the Perkins system is now, and for how long has it been, used in repairing asphalt pavements?

A. In Washington, since the Barber people brought it here in 1894. The Cranford Paving Company who have the contract for repairing concrete pavements in the city of Washington were ordered to use it by the Commissioners to determine its value, and this year their contract was so modified that repairing by the Perkins system is now a portion of their contract.

Q. 204. Please state, if you know, why the contract with the Cranford Paving Company was modified as stated in your last answer, and what advantage results to the District of Columbia, and to the contractor if you know, from the repairing of asphalt pavements in Washington by the Perkins method.

A. I do not know what advantage it is to the contractor, except that my observation would lead me to believe that he can do the work in a better and cheaper manner to himself. The

133 Commissioners of the District of Columbia were no doubt convinced by the reports of their subordinates that the District would be materially benefited by the change in the system of repairs, in those cases where the Perkins system can be used.

Q. 205. Please state whether you made any such reports as

you have referred to in your last answer, and also state, if you know, who made any recommendation to the District Commissioners favorable to the adoption of the Perkins method of repairing asphalt pavements?

A. The reports are no doubt on file in the office of the Commissioners, the origin of these reports were the result of the use by the Cranford Paving Company of the Perkins heater system on various streets, particularly on the West side of Dupont Circle between 19th street and Massachusetts Avenue. Inspector Reilly, who was under me, and who had direct charge of the work on the street, submitted to me, at my request, some figures which we examined together; the result of said examination was that we were confident that the cost of repairs was much less on the streets we had figured on than it would have been under the old system. These various papers and reports went to our superiors, and resulted as I have said before. The contract with the Cranford Paving Company, which is in its last year of its five years duration, was so modified as to allow the Perkins system to be used.

Cross-Examination by Mr. Peirce.

X. Q. 206. What was your first position under the District government in 1888?

A. I was appointed superintendent of streets July, 1888; having been promoted from Assistant Engineer of the Engineer Department, Surface Division.

134 X. Q. 207. Have you been Superintendent of streets since July, 1888?

A. I have.

X. Q. 208. How long have you been in the employ of the District government?

A. Since 1886.

X. Q. 209. How long have you been familiar with the methods observed in laying and in repairing asphalt pavements?

A. Since 1888.

X. Q. 210. During the period since 1888 what, to your knowledge, were the sources of the asphalt composition employed either in laying or repairing such pavements?

A. Trinidad Lake asphalt, Bermudez asphalt. That's all.

X. Q. 211. Do these materials you mention come here in readiness to be applied to the pavements?

A. Never, to my knowledge.

X. Q. 212. They go through some sort of preliminary treat-

ment before they are ready for use in laying pavements, do they not?

A. They do.

X. Q. 213. Is it a part of your duty to supervise such treatment?

A. It is not.

X. Q. 214. Whose duty is it to do so?

A. Inspector of asphalts and cements.

X. Q. 215. He is an officer under the District Commissioners; am I correct?

135 A. You are, but I have given his official title, Inspector of asphalts and cements.

X. Q. 216. What is the preliminary procedure you mention, and what is the condition of the asphalt materials, i. e., Trinidad and Bermudez, when they first come here for such treatment?

A. My observation extends only to Trinidad asphalt, which I have seen unloaded from a vessel, which vessel brought it from Trinidad. It had to be picked out of the hold of the vessel like any other stuff that had run together.

X. Q. 217. After the crude material is removed from the hold of the vessel is it heated in tanks or pans during several days to "try" out the bitumen from the associated refuse?

Mr. Raymond: Objected to as irrelevant and immaterial.

A. I do not know.

X. Q. 218. What are the cases, in your observation, where the Perkins method of repair is inapplicable?

A. Where the portion of the material to be replaced in the asphalt pavement is a long narrow strip, because it would also destroy good pavement which would not necessarily have to be replaced. By narrow strip I mean two, three to four inches wide.

X. Q. 219. Is this method applicable for the repair of pavements having a coal-tar composition wearing surface?

A. The orders of the Commissioners are not to repair coal-tar pavements with the Perkins heater system.

X. Q. 220. I did not ask about any orders, but whether 136 as a matter of fact Perkins method was applicable for the repair of coal-tar composition pavements; did you know as to this from practical experience?

A. I do not.

X. Q. 221. Did you ever know the use of a wood fire applied directly to the surface of an asphalt pavement to soften the same?

A. I do not know of any such case.

X. Q. 222. Did you ever know of the use of a charcoal brazier

fire applied above the spot for softening the asphalt pavement beneath?

A. I do not know of any such application.

X. Q. 223. Did you ever know of the heating of the edge rim of the laid asphalt pavement—prior to the Perkins system—for the purpose of softening such rim before the application of a fresh hot filling to be united thereto?

A. My recollection is that the Barber Asphalt Paving Company in laying new asphalt pavements used a hot smoothing iron where they commence the work at the joint of the previous leaving off; that is the only kind of an application that I can recall, and that is not directly similar to the work done by the Perkins Heater.

X. Q. 224. So far as the softening of the edge rim is concerned how does it differ therefrom?

A. It is a smoothing iron applied to the top of the two finished surfaces.

Re-direct Examination by Mr. Raymond.

R. D. Q. 225. You have been asked on cross-examination about the joint between the new asphalt added and the
137 old, and I now ask you to state, if you know, whether a joint or union between the new material added in making a patch, at the edge rim or side edges of the cut, is any more or less important than the joint between the body of the material added and the body of the old or laid material after being treated with a Perkins Heater, as the repairs are made under the Perkins system?

A. As I understand the question it is not considered by us a proper repair unless the old material and the new material goes properly together at the joint as well as on the bottom; otherwise water could enter the joint, and in making repairs our object is always to go far enough back to get good material to join on to, otherwise the patch would not last.

R. D. Q. 226. Please state what you mean, in your last answer when you say "our object is always to go far enough back to get good material to join on to." Back where?

A. Back into the sheet pavement where the patch or repair is being made.

Re-cross Examination by Mr. Peirce.

R. X. Q. 227. At the bottom of the heated spot what decides the operator as to the amount of old material to be raked off?

A. His judgment, probably, in other places than Washington. In Washington the specifications require three-quarters of an inch at least.

R. X. Q. 228. Is there any difference between the old material raked off and that which still remains in the spot?

A. There is. The raked off material may contain some
138 good material, but the portion remaining must be good.

R. X. Q. 229. What is there about the raked off material that is bad?

A. It may be either too rich in the first place, or it may have become poor in quality.

R. X. Q. 230. As the result of the Perkins treatment does the raked off material show that it is coked or burned?

A. From my observation I should say it was not, unless through carelessness of the workmen, and not the fault of the system. I can recall no place where I have seen it either coked or burnt.

R. X. Q. 231. Since the original layer is homogeneous in vertical depth why should the part raked off be any more defective than the part which is allowed to stay at the spot?

A. As I understand the question the repair would not be made if the material were homogeneous from top to bottom, except where it is necessary to restore the proper surface grade of the pavement, and it may happen in those cases that the material is good that is taken out or removed.

R. X. Q. 232. In restoring the grade at a depressed spot is the contractor permitted to leave the softened old material—without raking off—if the original layer is shown to be homogeneous and of good quality?

A. Not under the District specification, we must burn out and rake out at least three quarters of an inch.

R. X. Q. 233. What in your opinion would be the quality of the repair if no part of the heated old material were raked off?

139 A. I should not call it a good repair.

R. X. Q. 234. From which I understand that unless some part of the old material is raked off, exposing a fresh surface beneath the union of the new filling and old at the bottom of the patch will be apt to be insecure?

A. My experience is, as stated before, it is necessary in order to made a good repair to go back or go to assured good material.

H. N. MOSS.

Thereupon the solicitor for the complainant announces that the prima facie proofs are closed.

It is stipulated and agreed between the solicitors for the respective parties that the defendants shall close their proof on or before November 30th next, and that the complainant shall close its proof in rebuttal on or before December 31st next, and thereupon the parties adjourned subject to notice.

United States of America, }
District of Columbia. } ss.

I, J. Fred. Kelley, a Notary Public in and for the District of Columbia, do hereby certify over my hand and official seal, that upon the 4th, 5th and 6th days of October, 1897, in the case of United States Repair and Guaranty Company vs. Assyrian Asphalt Paving Company, now pending in the U. S. Circuit Court for the Northern District of Illinois, at my office in the City of Washington, I duly swore and took the depositions as above written of the following witnesses, William Y. Warren, of Buffalo, New York; Joseph H. Cranford, of Washington, D. C.; 140 William H. Lober, of Philadelphia, Pennsylvania, and Henry N. Moss, of Washington, D. C.; that Mr. James H. Raymond conducted the examination for the complainant, and Mr. James H. Peirce conducted the examination for the defendant, and made objections and stipulations as above written; that said depositions were taken directly upon a typewriter by Horace L. Beall, and were duly examined and signed by said witnesses.

Witness my hand and official seal this 7th day of October, A. D. 1897.

J. FRED. KELLEY,
(Seal) Notary Public in and for said District

Notary's fees paid by complainant $18.10.

Fig. 1. – Perf. View, with part of the top of the hood broken away

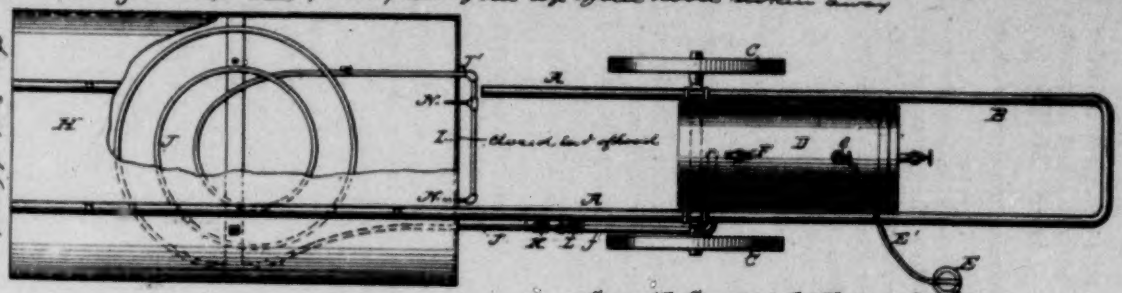
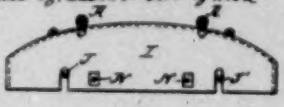
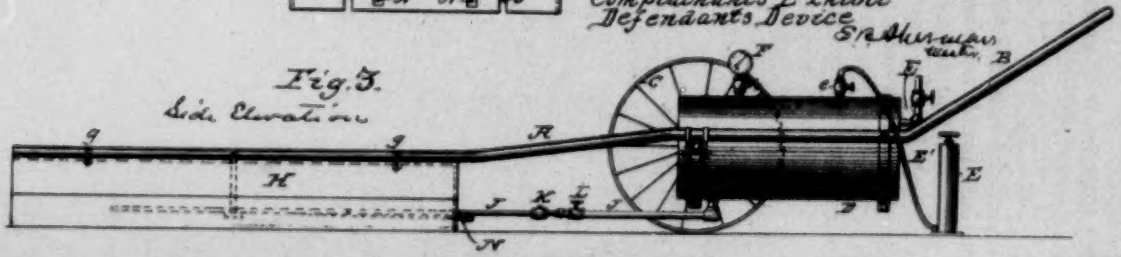


Fig. 2.
View of closed end of hood



Circuit Court of the United States
Northern District of Illinois
United States Repair and Guaranty Co
vs
Assyrian Asphalt Co. et al
No. 24,534
Complainants Exhibit
Defendants Device
E. P. Sherman

Fig. 3.
Side Elevation



143 UNITED STATES CIRCUIT COURT.

NORTHERN DISTRICT OF ILLINOIS.

No. 24,534.

United States Repair & Guaranty Company,
vs.
Assyrian Asphalt Company and James P. Mallette.
} In Chancery.

TESTIMONY FOR DEFENDANTS.

Chicago, December 7, 1897.

Proceedings taken on Defendants' behalf under Rule 67 in equity practice, as amended, in office of Peirce & Fisher, 115 Monroe Street, Chicago, Illinois, by mutual consent, formal notice being waived, before Alberta Adamick, Notary Public and Special Examiner by agreement, commencing at 2:00 o'clock p. m., Tuesday, December 7, 1897.

Present: Mr. William R. Omohundro, solicitor for complainant; Mr. James H. Peirce, solicitor for defendants.

To show the state of the art prior to the dates of the respective Perkins inventions here in controversy Mr. Peirce on de-
144 fendants' behalf offers in evidence the following:

(A) Authenticated copy (verified by the United States Vice-Consul, Paris, France), of French patent No. 137,208, granted to Paul Crochet June 11-August 25, 1880, for a process for the reparation and re-charging of compressed asphalt roadways, and the same is entered and marked "Defendants' Exhibit Crochet Patent."

It is stipulated between the solicitors for the respective parties that the patent law of France in force at the date of said Crochet patent, viz.: No. 137,208, June 11, 1880, delivered August 25, 1880, was then and ever since has been the same as set forth, by translation, in Official Gazette, United States Patent Office, Vol. II., pp. 565-568 inclusive, and (subject to rectification of possible faults in such translation) it is further stipulated that said French law may now be treated as duly proven and offered in evidence. It is further stipulated that said Crochet patent was procured at the date of the delivery thereof as hereinbefore noted, in due

keeping with the laws of France, and that on and after such delivery the original specification and drawing of said patent became accessible forthwith to the public at the Ministry of Agriculture and Commerce. But, so far as now known, no publication of said specification and drawing in printed form has thus far occurred.

It is further stipulated that the copy of said Crochet patent now in evidence is true and authentic and is duly verified by the lawful officials having competent authority in such behalf.

To further show such prior state of the art defendants' solicitor offers in evidence photolith, copies from various earlier printed publications, viz.:

145 (B) Annales des Ponts et Chaussees, Memoires et Documents, 4e. serie, 1861 1er. semestre, pp. 69-91, article entitled "No. 4. Note sur l'asphalte," and the same is entered in evidence and marked "Defendants' Exhibit Malo Article No. 1."

(C) Memoires et compte-rendu des travaux de la societe des Ingenieurs Civils Paris, 1864, pp. 81-91, "Note sur les chaussees en asphalte comprime" par Leon Malo, and the same is entered in evidence and marked "Defendants' Exhibit Malo Article No. 2."

(D) Reports of United States Commissioners to Paris Universal Expositionof1867, Washington, Gov't Printing Office, 1869, Vol. IV, article entitled "Report on Asphalt and Bitumen" by Arthus Beckwith, pp. 1-15 with drawings, 3 Plates, and the same is entered in evidence and marked "Defendants' Exhibit Beckwith Article."

(E) Engineering: London, 1870, Vol. IX, March 18th, p. 179, article entitled "Asphalte Roads in Paris," and the same is entered in evidence and marked "Defendants' Exhibit Engineering Article."

(F) Minutes of the proceedings of the Institution of Civil Engineers, London, Vol. XLIII, 1876, part 1, pp. 276-295, article entitled "The Applications of Asphalt," and the same is entered in evidence and marked "Defendants' Exhibit Chabrier Article."

(G) Annales des Ponts et Chaussees: memoires et documents; 5e. serie Tome XVIII, 1879, 2me. semestre, pp. 298-302, under the general article, viz: "etat actuel de l'industrie de l'asphalte," the sub-title designated "Reparations de l'asphalte comprime," beginning at p. 298, and the same is stated to be an extract
146 from an article by Leon Malo entitled "etat actuel de l'industrie de l'asphalte" and is entered in evidence and marked "Defendants' Exhibit Malo Article No. 3."

(H) Minutes of the proceedings of the Institution of Civil Engineers, London, Vol. LX, 1880, pp. 302-307, being the whole of a sub-article entitled "correspondence on asphalte," and the same is entered in evidence and marked "Defendants' Exhibit Correspondence on Asphalt."

(I) L'asphalte: son origin, sa preparation, ses applications. Leon Malo; deuxienie edition Paris, 1888, pp. 108-115; "Entretien des chaussees," and the same is entered in evidence and marked "Defendants' Exhibit Malo Book."

It is stipulated that the several articles named, subject to correction wherein errors may appear, were published in printed form at the dates respectively specified therefor. Objection to articles (B), (C), (G) and (I) is reserved by consent until translations thereof or such of said articles as defendants may later specify shall have been served and settled.

Counsel for complainant objects to the materiality, competency and sufficiency of all of the exhibits above offered.

Defendants' solicitor offers in evidence certified copies of the respective file wrappers and contents of the several Perkins letters patent here in suit, viz:

(K) Application for patent No. 501,537, A. H. Perkins, July 18, 1893, Improvement in the Method of Repairing Asphalt Pavement, and the same is marked "Defendants' Exhibit Perkins method File."

(L) Application for patent No. 542,349, A. H. Perkins, 147 July 9, 1895, Improvements in Apparatus for Repairing Asphalt Pavements, and the same is marked "Defendants' Exhibit Perkins Apparatus File No. 1."

(M) Application for patent No. 560,599, A. H. Perkins, May 19, 1896, Improvement in Apparatus for Repairing Asphalt Pavements, and the same is marked "Defendants' Exhibit Perkins Apparatus File No. 2."

To further show the prior state of the art defendants' solicitor offers in evidence letters patent of the United States as follows, viz:

(N) No. 8,701, J. A. Craig, February 3, 1852, Gas Burners, and the same is marked "Defendants' Exhibit Craig Patent."

(O) No. 5,697 (reissue), M. C. Bogia, December 23, 1873, Machines for Removing Snow and Ice from Roadways, and the same is marked "Defendants' Exhibit Bogia Patent."

(P) No. 145,822, C. G. Waterbury, December 23, 1873, Machines for Removing Snow and Ice from Roadways, and the same is marked "Defendants' Exhibit Waterbury Patent No. 1."

(Q) No. 157,559, C. G. Waterbury, December 8, 1874, Machine for Melting Snow, and the same is marked "Defendants' Exhibit Waterbury Patent No. 2."

(R) No. 169,439, J. P Hayes, November. 2, 1875, Paint Breamers, and the same is marked "Defendants' Exhibit Hayes Patent."

(S) No. 184,628, I. Kendrick, November 21, 1876, Machines for Melting Snow and Ice, and the same is marked "Defendants' Exhibit Kendrick Patent."

(T) No. 269,368, A. F. Zimmerling, December 19, 1882, Combined Smoothing, Fluting and Polishing Iron, and the same 148 is marked "Defendants' Exhibit Zimmerling Patent."

(U) No. 383,346, J. B. Curl, May 22, 1888, Self-Heating Flat Iron, and the same is marked "Defendants' Exhibit Curl Patent."

(V) No. 531,648, Risdon-Toliver, January 1, 1895, Fire Guard and Back Firing Machine, and the same is marked "Defendants' Exhibit Risdon Patent."

To show the state of the art, and as well in support of defendants' denial by answer respecting the right to recover damages and profits, defendants' solicitor offers in evidence a copy of United States letters patent, No. 501,536, Amos. H. Perkins, July 18, 1893, Apparatus for Repairing Asphalt Pavements, and the same is marked "Defendants' Exhibit Perkins Senior Apparatus Patent."

It is conceded by solicitor for complainant that the Perkins patent last offered in evidence was owned by the complainant at the time this suit was brought.

Adjourned until Wednesday, December 8, 1897, at 10:00 o'clock A. M.

Wednesday, December 8, 1897, 10:00 o'clock A. M.

Met pursuant to adjournment. Present: solicitors as before.

Mr. Peirce: In event it shall later be deemed advisable to amend defendants' answer so as to plead formally the various matters offered yesterday to show the state of the art defendants' attorney reserves the right to do so, as the court may allow.

Mr. Peirce: At the session yesterday, defendants' solicitor had occasion to offer in evidence extracts from various printed 149 publications designated by marginal letters on the Examiner's record, as entries (B) to (I), inclusive.

Objection was then made to all such exhibits because they were said to be lacking in "materiality, competency, and sufficiency." Defendants' solicitor wishes to know why said exhibits are deemed "incompetent" to the end that he may correct the possible defect and avoid continued objection on this head.

Mr. Omohundro: Counsel is informed that the objection inquired about was made at that time upon the record because of the nature of the offer of the matter, and in view of counsel's opening statement this morning it is desired by complainant that the objections noted shall stand with the understanding that in event amendment to the answer is made that the objections as to incompetency should be withdrawn.

LEWIS M. SMITH, a witness called on defendants' behalf, being first duly sworn, makes answer to the questions of defendants' solicitor as follows:

Q. 1. State your name, age, residence and occupation?

A. Lewis M. Smith; age, 32 years; 962 72nd street; street foreman for the Assyrian Asphalt Company.

Q. 2. Is the Assyrian Asphalt Company one of the defendants here?

A. They are.

Q. 3. How long have you been in the employ of such company?

A. Since November, 1895.

150 Q. 4. Where and for whom had you been working just before then?

A. For the Wasatch Asphalt Company, Salt Lake, Utah.

Q. 5. What was the business of the Wasatch Asphalt Company?

A. Street paving and laying sidewalks.

Q. 6. About when was it that you began your connection with the Wasatch Co.?

A. I think it was in the Spring of 1890. I am not certain as to the date.

Q. 7. Before you went into the employ of the Wasatch Co. were you connected with any other concern engaged in laying asphalt pavements or sidewalks?

A. Yes, sir.

Q. 8. Where and for whom?

A. At Thistle, Utah—North American Asphalt Company.

Q. 9. About when was it you first began your connection with the North American Co.?

A. In January, 1888.

Q. 10. Had you any practical knowledge prior to January, 1888, in regard to the laying of asphalt pavements or sidewalks?

A. No.

Q. 11. Give us briefly an idea of the nature and extent of your experience in laying asphalt pavements since January, 1888?

A. The first pavement that I laid was in the engine room floor at the mill at Thistle, also a floor in still house and the side-
151 walk at the Superintendent's house. The next work I done was sidewalks in Provo City, Utah. In 1892 I laid Richard Street in Salt Lake City; in '93 Main Street and other streets in Salt Lake City. Commencing in 1896 in Chicago I have laid all the streets that the Assyrian Asphalt Company had contracts for; also one contract in Grand Rapids, Michigan.

Q. 12. During this experience have you had occasion to employ as a paving material natural asphalt rock ground fine, heated and then without further addition dumped into place, leveled off and tamped to compress the material into a sheet?

A. Yes, sir.

Q. 13. What sort of a natural rock was that?

A. Bituminous sand stone.

Q. 14. I call your attention to the drawing in Defendants' Exhibit "Crochet Patent" which—you may assume—is designed to show a perforated car body or brazier mounted adjustably upon wheels and having a grate bottom to sustain the live coals. Between the grate and the pavement beneath, the car carries a metal plate to arrest the fall of the ashes and to radiate the heat against the pavement surface under it. A handle enables the operator to manipulate the car over a selected part which he designs to soften prior to making a repair there. The top dressing for the pavement, we will assume, is two inches thick and composed of natural limestone asphalt without further addition. The spot being heated, the operator rakes off say one-half to three-quarter inches of the top dressing, thus exposing in softened state a fresh surface of the rock asphalt at the bottom and rim of the hole. New rock
152 asphalt is dumped into the cavity while heated—as in laying a full street pavement—spread out, tamped and rolled to unite with the subjacent or adjacent and softened part of the hole. The result—we will assume—is to perfectly repair or patch the defect so that the fresh addition is united to the softened part of the pavement at the hole without break or crack.

In your opinion is the machine shown by said Crochet drawing

capable of being used for heating a defective spot in the pavement as I have just defined?

The question is objected to as incompetent, the witness not having been shown to have any experience whatever in the repair of rock asphalt pavements or any other kind of asphalt pavement with an apparatus similar to that shown to him, or any other apparatus. The question is further objected to as leading.

A. Yes, sir.

Q. 15. Have you had any experience in repairing asphalt pavements?

A. Yes, sir.

Q. 16. What was your first experience of this sort?

A. In repairing the engine room floor at Thistle, Utah.

Q. 17. What was the character of such defect, and how did you proceed to remedy it?

A. It was a crack; I repaired it by laying a piece of sheet-iron over the crack, put in live coals from under the boiler, softening up the pavement, removing part of it, adding fresh material, tamping it and smoothing it.

Q. 18. What kind of a pavement material was in that boiler room floor?

153 A. Bituminous sandstone; sometimes called sandstone asphalt.

Q. 19. What kind of material was used for the repair?

A. The same kind.

Q. 20. You speak of using a piece of sheet-iron over the crack; what was that sheet-iron for?

A. To hold the fire.

Q. 21. What fire do you refer to?

A. The live coals that I took from under the boiler.

Q. 22. Since that first occasion, have you been engaged in the repair of asphalt pavements at various times?

A. Yes, sir.

Q. 23. Did you have anything to do with the repairs of asphalt pavements by the Assyrian Asphalt Company, respecting which this suit was brought?

A. Yes, sir.

Q. 24. Who built the heaters used by said Assyrian Company in this connection?

A. I did.

Q. 25. In connection with complainant's exhibit drawing "De-

fendants' Device," I call your attention to the cocks marked "K" and "L" located on the supply pipe J, between the tank D and the burner coil; what sort of devices are the cocks "K" and "L" there shown?

A. "L" is a globe valve to control the flow of the oil; "K" is a swinging check valve.

Q. 26. If you have a sample of such valves as used by you 154 on defendants' machines, will you kindly produce the same?

A. Yes, sir; here it is.

The sample referred to by the witness is offered in evidence and marked "Defendants' Exhibit Defendants' Valves."

Q. 27. This exhibit "Defendants' Valves," just produced by you—where did it come from?

A. It was taken off from one of the burners by me.

Q. 28. Does that exhibit display the globe valve and swinging check valve you mention?

A. Yes, sir.

Q. 29. Which one of these valves has the hand wheel attached thereto?

A. The globe valve.

Q. 30. On this exhibit the check valve at its crown is formed with a squared top. What is that squared top for?

A. The top is square so as to use a wrench in taking off the top or cap.

Q. 31. When do you want to take off the cap of this valve?

A. It is necessary to take off the cap to put the valve together or at any time when it needs repairing.

Q. 32. Is this top turned at any time to control the flow of liquid through the feed pipe?

A. No, sir. It would be impossible to control it by turning the top of the cap.

Q. 33. The flap plate or valve proper on this cock opens in which direction—to or from the tank?

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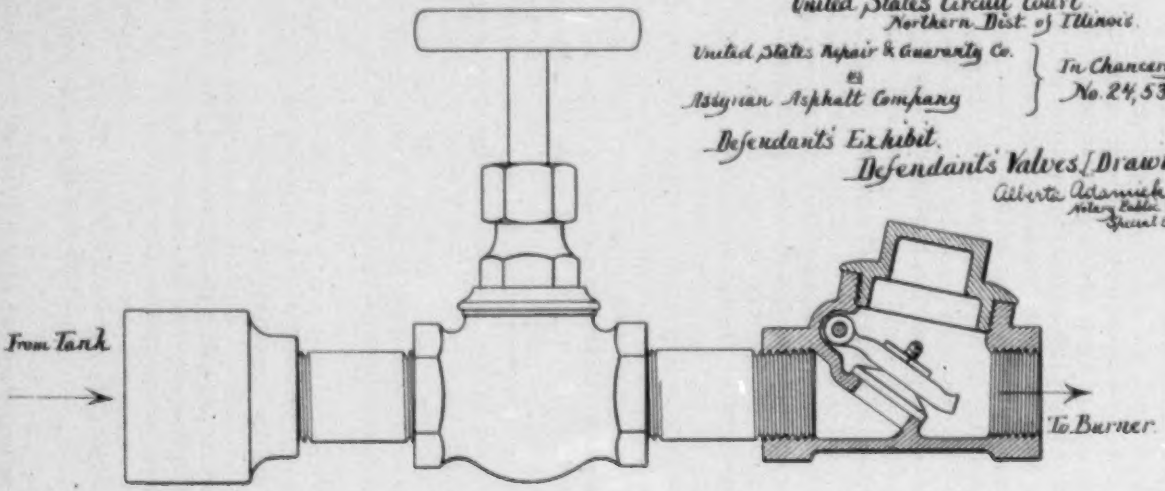
United States Circuit Court
Northern Dist. of Illinois.

United States Asphalt & Guaranty Co.
vs
Assyrian Asphalt Company
} In Chancery No. 24,534.

Defendant's Exhibit.

Defendant's Valves [Drawing].

Alberta Adamiak
Notary Public & Special Comr.



157 A. From the tank.

Q. 34. What is the purpose of using this check valve in the feed pipe?

A. To prevent back pressure from the coil to the tank.

Q. 35. In practice do you know whether or not such check valve does prevent the back pressure, as you have stated?

A. It does.

Cross-Examination by Mr. Omohundro.

XQ. 36. How do you secure your initial pressure in the tank D?

A. By an air pump.

XQ. 37. Is the discharge nozzle or opening in the burners N equal to the capacity or cross area of the feed pipe J?

A. No, sir.

XQ. 38. It is a fact, is it not, that under the influence of the heat from the burners to which the coil under the hood is subjected the fuel is converted into a gas at considerable pressure in the coil?

A. Yes, sir.

XQ. 39. Have you any idea as to what pressure would normally exist there during the operation of the machine?

A. Twenty-five pounds to the square inch, or nearly so.

XQ. 40. What pressure do you initially produce in the tank by the air pump?

158 A. Twenty-five pounds to the square inch or nearly so.

XQ. 41. Under equalized pressures between the tank and the coil would there in your judgment be any flow from the tank to the coils or vice versa?

A. No, sir.

XQ. 42. What was your object in desiring to avoid back pressure in the tank?

A. It was designed to avoid blowing up of the tank by excess pressure.

XQ. 43. Is it not a fact that the fuel, which I assume to be gasoline, and if I am not right you will please correct me, will not raise the check valve and flow past it to the burners unless the pressure in the tank exceeds that in the coil?

A. The fuel used is naphtha; and it is necessary to have greater pressure in the tank than in the coils in order that the fuel shall flow past the check.

XQ. 44. In your daily practice with defendants' device what

means are employed for maintaining pressure in the tank and how often is the pressure replenished?

A. Pressure is maintained by means of an air pump and is replenished about every ten or fifteen minutes.

XQ. 45. About how often is the fuel replenished in the tank?

A. Every two and a half hours to three hours.

XQ. 46. Your two previous answers assume the continuous operation or use of the machine, do they not?

A. Yes, sir.

XQ. 47. To about what degree of heat is the coil under the hood subjected?

159 A. In my judgment about eight hundred degrees.

XQ. 48. Is the globe valve "L" left continuously open during the operation or use of the machine?

A. Not wide open.

XQ. 49. But it is left continuously partly open, is it not?

A. Yes, sir.

XQ. 50. And, during the operation or use of the machine it is your opinion that there is a practically constant pressure of twenty-five pounds to the square inch in the coil under the hood. Am I correct?

A. The pressure in the coil under the hood will vary according to the pressure in the tank. Sometimes it will be a little greater and sometimes less than the pressure of the tank.

XQ. 51. In what way does the pressure in the tank effect or control the pressure in the coil?

A. When the pressure in the coil is less than the pressure in the tank the oil is forced through the check valve into the coil and generated into gas. After the oil is generated into gas the pressure in the pipe exceeds that of the tank, the check closes, remains closed until the pressure is less than that in the tank by reason of the gas escaping from the burner. When the pressure is less in the coil the valve opens and allows more oil to flow into the coil.

XQ. 52. In other words, the feed of the oil and the generation of gas is automatically controlled by the variation of pressure between the tank and the coil. Is that correct?

A. No, sir. It is controlled by the globe valve.

160 XQ. 53. I think you have already stated that the globe valve, during the operation of the machine, is continuously open to some extent. How does that valve have anything to do with the feed of the oil except to start or stop the feed or vary the amount fed?

A. It is only open enough to allow the right quantity of oil to pass the valve.

XQ. 54. I have, of course, assumed that the globe valve must be open in order to have any operation of the machine, and I now ask you to answer question 52 with that understanding?

A. It would be controlled by the variation in pressure between the coil and the tank.

XQ. 55. Under the operating conditions of the machine is it your opinion that no pressure can at any time pass from the coil back to the tank?

A. Yes, sir.

XQ. 56. Please explain why not?

A. When the pressure in the coil is less than the pressure in the tank it will allow the check valve to open, the pressure in the tank forcing the oil through it. When the pressure in the coil is greater than the pressure in the tank it will close the check valve, preventing any back pressure to the tank.

XQ. 57. Do I understand you to say that in the practical use of defendants' device it is necessary to maintain as near as possible a substantially uniform pressure of twenty-five pounds per square inch in the tank?

A. We obtain the best results by carrying about that pressure. It is not necessary to maintain that pressure.

161 XQ. 58 Under what range of pressures in the tank can you obtain practically satisfactory results?

A. From fifteen to thirty pounds.

XQ. 59. Why is it necessary to maintain a pressure of from fifteen to thirty pounds in the tank in order to get practically satisfactory results?

A. It is necessary to have that pressure to get sufficient blast from the burners to do the work.

XQ. 60. Do you mean to get sufficient blast or to get sufficient heat, or both?

A. Both.

XQ. 61. The drawing complainant's exhibit "Defendants' Device" is in all essential features, except as to the valve "K," a correct representation of the machines used by defendants and constructed by you, is it not?

A. Yes, sir.

XQ. 62. Have you read the deposition of complainant's expert witness, Mr. Dayton, particularly that part in which he describes the construction and operation of defendants' device?

A. No, sir.

XQ. 63. I hand you a copy of complainant's printed record and ask you to read that part of Mr. Dayton's deposition, pages 36 to 40, and state whether his description of the construction and mode of operation of defendants' device is correct, so far as the description applies to defendants' machine.

A. It is correct.

XQ. 64. Have you ever seen one of complainant's machines constructed in substantial accordance with the drawings of
162 Perkins' patent, No. 560,599, of which you will find a copy at the back of complainant's record?

A. I have never seen one or near enough to it to identify it as being like this copy.

XQ. 65. From what did you construct defendants' device?

A. I got the first idea of the machine from one that I saw on Park avenue, Chicago, in use by the Bermudez Asphalt Company.

XQ. 66. When was it that you saw this machine?

A. Some time in May of this year.

XQ. 67. What is the character of material used by the defendant in laying and repairing pavements?

A. The material is Utah lime rock asphalt, mixed with maltha and sand in right proportions.

XQ. 68. Please state whether the Utah lime rock asphalt is used in the mixture in its crude state or after refining it?

A. In its crude state.

XQ. 69. What are the proportions of asphalt, maltha and sand used in the mixture?

A. I don't know.

XQ. 70. Do you know what temperature or what degree of heat is necessary to properly combine these elements?

A. Yes, sir. From two hundred and sixty degrees to three hundred degrees.

XQ. 71. About what degree of heat would be necessary to resoften the asphalt mixture to the depth of say a half inch to an inch under the practical conditions of repair upon the street?
163 Mr. Peirce: The question objected to as indefinite unless the witness is advised in respect to what is meant by "practical conditions."

Mr. Omohundro: The witness is advised that by practical conditions is meant the conditions of exposure to the elements, such as wind, rain, heat and cold, under which repairs upon a street paving must necessarily be made.

A. In my judgment about five hundred degrees.

XQ. 72. And that temperature would vary considerably, would it not, with the age of the laid pavement and the amount of traffic to which it has been subjected in use?

A. It would vary some.

XQ. 73. Did you ever try to repair an asphalt pavement with one of defendants' machines, in which the top dressing was composed wholly of a natural or a rock asphalt without the addition of any other material thereto?

A. No.

XQ. 74. Did you ever repair or attempt to repair, with one of defendants' machines or a similar machine, an asphalt pavement in which the top dressing is composed wholly of either lime rock asphalt or sand stone asphalt?

A. No, sir.

XQ. 75. Have you ever repaired or attempted to repair, with defendants' machine or any similar machine, an asphalt pavement in which the top dressing is composed wholly of German rock asphalt?

A. No, sir.

164 XQ. 76. Did you ever repair or attempt to repair with an apparatus like that shown in the drawing of the Crochet patent any asphalt pavement in which the top dressing or layer was composed wholly of any natural or rock asphalt?

A. No, sir.

XQ. 77. Did you ever repair or attempt to repair, with apparatus like that shown in the drawing of the Crochet patent, any asphalt pavement laid by the Assyrian Asphalt Paving Company, the defendant, or any other asphalt pavement in which the top dressing is composed of a mixture similar to that used by the defendant?

A. Yes, sir.

XQ. 78. Please state where and when and the results of your attempt?

A. Last July, as near as I can remember, on 69th street and Kimbark avenue. It was unsatisfactory and for the reason that it was too slow and too expensive.

XQ. 79. If you can, please make a drawing of the machine that you used in making your attempts at repairs above referred to and describe the construction and manner of use of the machine in connection with the drawing.

A. I have made a drawing and here produce it. The body of the

machine was an oblong box ten feet long, eighteen inches wide, twelve inches deep, made of No. 10 iron. The sides of the box are marked A, the ends B and the bottom C. Inch-and-a-half angle iron is riveted around the top, being riveted to the sheet iron sides and ends. At the lower edge of the sides and ends the sheets are flanged outward about one inch to form a foot as at E. Around the inside, angle irons are riveted to the side sheets at the
165 bottom to support the pipes F on said angle irons G. The pipes F are five in number, separated equally to sustain a wire screen H which forms the grate or otherwise designated as bottom C. At the front end the box carries two hooks I which set over the axle K sustained by the carrying wheels L located at the sides of the machine; the hooks are put on in position to raise the box off the ground about one inch. At the rear are rings in the angle iron to receive bars or handles to move the machine with. The same kind of rings being at the front end to remove the machine from the wheels so that the machine may lie flat on the pavement.

Adjourned until Thursday, December 9, 1897, at 10:30 o'clock a. m.

Chicago, December 9, 1897, 10:30 o'clock a. m.

Met pursuant to adjournment. Parties present by their solicitors as before.

Cross-examination of the witness Smith resumed.

XQ. 80. Please state how far, in the use of the machine you have described, the fire was from the surface of the pavement, and whether anything in the nature of a plate or sheet of metal was interposed between the fire and the pavement surface as occurs in the drawing of the Crochet patent indicated at "D"?

A. The fire would be about three inches from the surface of the pavement. There is no plate between the fire and the pavement.

XQ. 81. And, if I understand you correctly, when the repair was made the carrying wheels "L" were removed and the box or heater was set directly upon the pavement. Is that the fact?
166 A. No, sir. The machine placed over the spot to be repaired is left there until the pavement is sufficiently softened to proper depth.

XQ. 82. Do you mean to say that while the pavement is being

heated the box rests on the ground at one end and is supported on the wheels at the other?

A. Yes, sir.

XQ. 83. What is your purpose in having the wheels readily detachable in the way they were made?

A. Made four of the machines and used only one pair of wheels, so that if using more than one machine at a time we could handle them all with the same set of wheels. The machine was made as an experiment.

XQ. 84. If the apparatus or the machine that you have drawn proved unsatisfactory, in your opinion, would an apparatus like the Crochet patent having a plate interposed between the fire and the pavement be more or less successful for such a use as you have attempted to make of the machines?

Mr. Peirce: Question objected to unless made plain to the witness as to the sense of the use of the word "unsatisfactory." Unsatisfactory in dollars saved or unsatisfactory in that the machine did not work at all.

Mr. Omohundro: I don't think the witness has any doubt as to the meaning of my question. He can assume either or both meanings, as my question goes only to a comparison of what might be accomplished by the Crochet patented machine in view of witness' experience with his own machine.

A. I don't think there would be much difference.

XQ. 85. Did you succeed in making a perfect patch in
167 your experiments on 69th street and Kimbark avenue with the machines you have been testifying about?

A. Yes, sir.

XQ. 86. Is the repair still in place?

A. Yes, sir.

XQ. 87. At what part of the pavement did the repair to which you refer occur?

A. The full width of the street.

XQ. 88. Please explain the nature of the repair and whether the repair was at the intersection of the street or extended along one street or the other, so that we can fix the exact location?

A. Commencing at the intersection of Kimbark avenue on 69th street the pavement was repaired about 170 feet west. It was repaired by burning off from about three-fourths of an inch to one inch of the old pavement, removing it, placing fresh material on the street, raking it to proper grade and finishing it.

XQ. 89. In other words, you resurfaced the entire area of the portion of the street repaired. Is that correct?

A. Yes, sir.

XQ. 90. How long had the original pavement been laid at the time you re-surfaced it?

A. About eight months.

XQ. 91. What was the nature of the defects in the pavement necessitating the re-surfacing thereof?

A. Cracks.

XQ. 92. In making the repairs to which you have referred, was any use made of defendants' device—that is, the regular re-
168 pair machine illustrated in "Complainant's Exhibit Defendants' Device"?

A. No, sir.

XQ. 93. And, as I understand it, the pavement is still in perfect repair, and the defendants' device has never at any time been used upon the particular repair about which you have been testifying?

A. The pavement was in perfect repair the last time I saw it. The device you mention wasn't used in making that repair at all.

XQ. 94. In your direct examination you expressed the opinion that the device of the Crochet patent is capable of being used for heating a defective spot in a rock asphalt pavement. What, in your opinion, would be the result, if a repair were so made with such a machine upon such a pavement, when the pavement was subjected to traffic?

A. I can't tell what the effect would be.

Re-direct Examination by Mr. Peirce.

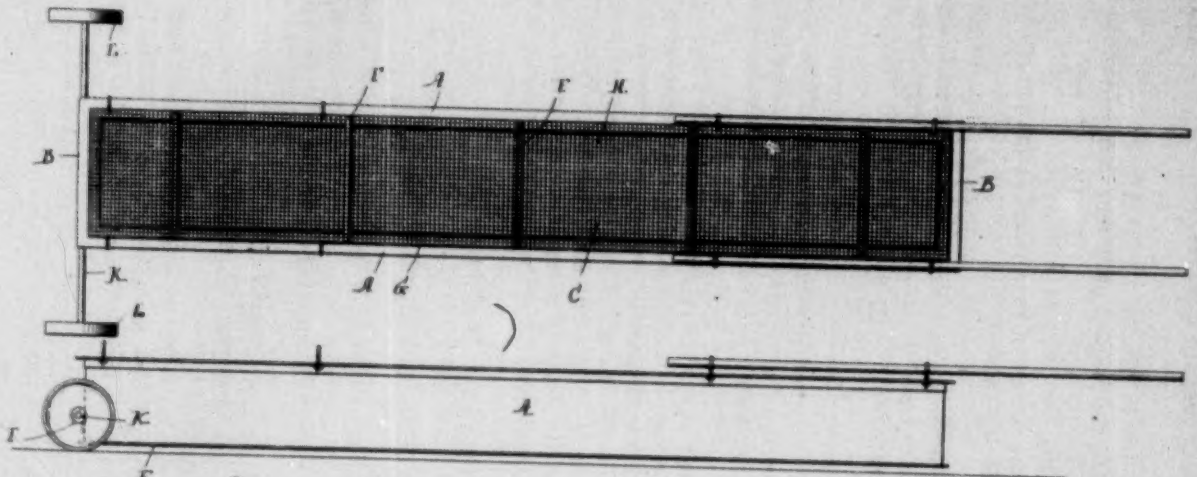
R.D.Q. 95. In heating an asphalt pavement surface which form of apparatus would be quicker in its action; a device like that shown in the Crochet patent or one of the Perkins type of apparatus.

A. One of the Perkins apparatus.

R.D.Q. 96. Which one of the two would be cheaper to use?

A. The Perkins apparatus.

Mr. Peirce: At the session yesterday p. m., complainant's solicitor requested the witness Smith to make a drawing of the machine used by the witness in effecting the repairs on 69th



Circuit Court of the United States.
Northern Dist. of Illinois.

United States Repair & Guaranty Co
Assyrian Asphalt Company
} In Chancery No 29,534

"Complainants Ex. Smith Drawing"

A. Curtis Adamson
Notary Public & Special Exmr.

171 street and Kimbark avenue. The witness complied with the request and produced the drawing which is here present. Does complainant's solicitor intend to introduce such drawing in evidence?

Mr. Omohundro: I have understood that the drawing is just as much a part of the record as any answer the witness has made, but have no objection to make a formal offer for the same if defendants' counsel so desires.

Mr. Peirce: I think it had better be identified in some fashion lest it may be lost.

Mr. Omohundro: The Notary is requested to mark the drawing for identification as Complainant's Exhibit "Smith Drawing."

R.D.Q. 97. Referring to the Smith drawing, will you kindly say whether machines of this sort proved economical in use?

A. No, sir.

R.D.Q. 98. What was the trouble on this head?

A. Used too much fuel and were too slow.

LEWIS M. SMITH.

Adjourned by consent until Monday, December 14, 1897, at 2:00 o'clock p. m.

Chicago, Illinois, Monday, December 14, 1897.

Met pursuant to adjournment. Present, attorneys for the parties as before. By mutual agreement, further proceedings are adjourned until Wednesday, February 9, 1898.

172 Chicago, Illinois, Wednesday, February 9, 1898.

Met pursuant to adjournment. Present, attorneys for the parties as before.

Mr. Peirce: In connection with the photolith. copies of various earlier printed publications put in evidence on defendants' behalf December 7, 1897, and there designated by marginal letter on Examiner's record, I now offer in evidence translations of the Articles severally specified as (B), (G) and (I), and serve copies of the same upon complainant's attorney in order to have such translations settled and accepted by mutual consent.

Mr. Omohundro: In view of the translations now offered—reserving the right to correct manifest errors therein—complain-

ant's counsel withdraws his objection to the "competency" of the several exhibits designated by marginal letter as (B), (G) and (I), respectively, just specified. Objections as to the materiality and sufficiency of these several articles are still preserved.

Mr. Peirce: As a contemporaneous declaration by the inventor to aid in the interpretation of Perkins patent No. 501,537, July 18, 1893, "Method of Repairing Asphalt Pavements"—here in suit—defendants' counsel offers in evidence a blue book copy of British patent No. 14,429, Amos H. Perkins, Chicago, Illinois, dated July 26, 1893, and entitled "Improvements relating to the repair of Asphalt Pavements and to Apparatus Therefor," and marks the same "Defendants' Exhibit Perkins British Patent."

LEWIS M. SMITH (recalled): In answer to questions by Mr. Peirce, defendants' solicitor, testified as follows:

Q. 1. Are you the same person who has heretofore testified for defendant in this suit?

173 A. Yes, sir.

Q. 2. In the repair of asphalt pavements as practised by you for defendant company do you have occasion to use what is termed "Dope?"

A. Yes, sir.

Q. 3. What is "dope" and how is it used?

A. A dope is asphalt mixed with oil that is used to paint the joints and sprinkled on the old material when making a patch.

Q. 4. At the time the "dope" is applied is it hot or cold?

A. Hot.

Q. 5. When "dope" is cold is it solid or liquid?

A. Solid.

Q. 6. In repairing a patch by the aid of "dope" must the spot be hot at the time the "dope" is applied thereto?

A. No.

Q. 7. State whether or not it is frequent practice with you to burn out and clear off the spot on one day and to apply the "dope," re-fill the hole with fresh material and complete the repair on the day following?

A. Yes, sir.

Q. 8. Is the practice last stated occasional or frequent with you?

A. Frequent.

Q. 9. Give us an idea of the extent of the repairs thus effected portion wise over two days?

A. Where there is a whole block or half a block or any very large patch we do it that way.

174 Q. 10. Is it general custom with you to paint the joint and sprinkle the bottom of the spot with the "dope" you mention before the fresh material is filled in and tamped down?

A. Yes, sir.

Q. 11. When a defective spot is heated by your procedure—preliminary to making a repair—is any part of the old material raked out from the hole before the fresh addition is supplied?

A. Yes, sir.

Q. 12. What is the reason for that?

A. The material that is raked out is burned.

Q. 13. This "burning" you speak of, is it of general occurrence or only occasional?

A. A general occurrence.

Q. 14. You may say whether or not it is always the practice to rake out a portion of the old material after heating the spot but before adding the new material.

A. Always rake it out as deep as it is softened.

Cross-Examination by Mr. Omohundro.

XQ. 15. It is a fact, is it not, that in the repairs of small area it is common for defendant, after heating the spot to be repaired and raking off the burned material, to add new material to fill up the depression while the old material is still in a heated state, thus making the repair one continuous operation?

A. Yes, sir; after painting the joint and the bottom of the hole with "dope."

XQ. 16. The "dope" when applied is in a liquid state, is it not?

175 A. Yes, sir.

XQ. 17. What is the purpose of using the "dope"?

A. It is to soften the two materials when they come together to make a solid joint.

XQ. 18. Do you consider the use of this "dope" essential to the making of a good repair?

A. Yes, sir.

XQ. 19. Have the defendants, within your knowledge, ever made any repair of any description without the use of "dope"?

A. Yes, sir.

XQ. 20. Then, as I understand your testimony, while the use

of the "dope" you personally believe to be essential to the making of the best repairs, the "dope" has not always or invariably been used by the defendants in making its repairs with the surface heater?

A. Yes, sir; it has.

XQ. 21. What did you mean by your previous answer?

A. In making that repair there was no heater used. It was a cut in the street made by the Water Department to repair a water main. I was sent to repair the hole and neglected to take any "dope" with me.

XQ. 22. Then, as I understand you, the defendants have never made a repair with a surface heater of any dimensions without using the "dope"?

A. Not to my knowledge.

XQ. 23. When the repair is made what becomes of the "dope"? In explanation I will ask you whether the "dope" forms an intermediate layer or seam between the old material and the new
176 material added, or whether it becomes incorporated in both the old and new material and disappears as a layer or body?

A. It becomes incorporated with the old and new material from the heat from the smoothing iron.

XQ. 24. Did you ever cut through a patch so as to ascertain whether the "dope" formed a seam or layer between the old material and the patch or the new material?

A. Yes, sir.

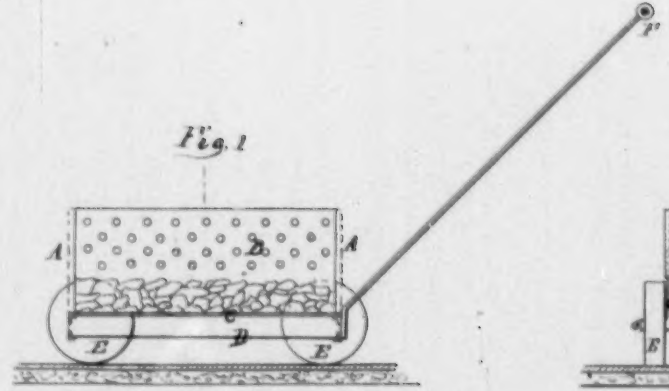
LEWIS M. SMITH.

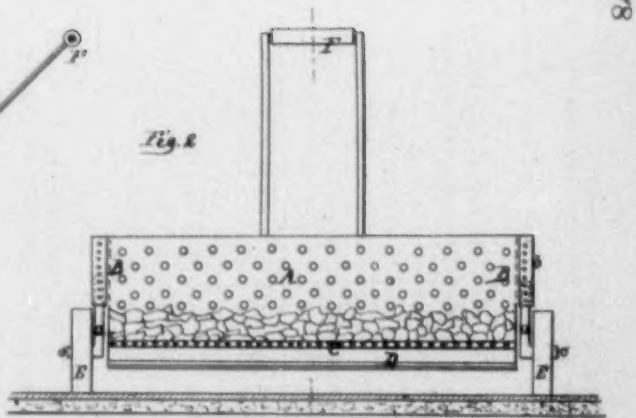
Defendants' counsel offer in evidence a copy of the official description of French patent No. 137,208, Crochet, June 11, 1880, for a Process for the Reparation and Recharging of Compressed Asphalt Roadways, as the same is set forth in and by the following printed publication: "Description Des Machines et Procedes, etc., Paris, 1886, Vol. XXXVII, 2nd part; Travaux de Construction 2 Ponts et Routes, pp. 7, 8," and the same is marked "Defendants' Exhibit Crochet Print."

Defendants' counsel also offers a translation of said description, which is accepted by complainant's counsel subject to correction for errors if any exist therein.

It is agreed between the solicitors for the respective parties that the exhibit last offered was published in printed form in the year 1886 and ever since such date has been available to the public.

Attorney for defendants announces that testimony on their behalf is now closed.





Echelle 1/10

Paris le 21 Juin 1880
P. P.on de M. Crochet
Signé, Armengaud Jeune

179 PAUL CROCHET, Pat. No. 137,208, dated June 11, 1880, for a process for the Reparation and Recharging of Compressed Asphalt Roadways.

SPECIFICATION.

When it is designed to repair or re-charge a roadway in asphalt with the means which are now at command, the operator generally delimits with a pick the part which is to be replaced and takes therefrom the asphalt; but it is rare that this operation has not for consequence the starting of the adjacent portions which are sound, swelling them up in such wise that at the end of a little while it is necessary to repair them in their turn.

To avoid this I have designed a process for repairing and re-charging asphalt roads which suppresses such inconveniences. It consists in reheating the part to be mended by means of a movable furnace which the operator shifts about at the surface of the roadway until such portion decrepitates and becomes friable. The upper part of the layer of asphalt and that which has been damaged are taken off by means of an iron scraper armed with small teeth which perform the office of a rake; said scraper in raising the material forms at the same time upon the part remaining numerous striae which render the surface wrinkled and augment the adherence of the additional over-thickness which constitutes the re-charge.

The repeated passage of the movable furnace thereon has equally for its effect to vaporize the water and the humidity which are found in the asphalt pavement at the portion to be repaired or re-charged.

After this preparatory operation, the workman spreads a convenient depth of asphalt in powder-like state and stamps it by the ordinary means; because of the softening of the subjacent layer said layer solders itself perfectly to the new coat and forms with it a thickness without break in continuity. Such repair and
180 such re-charging do not at all impair the neighboring portions.

It is clearly evident, besides, that the same work of re-chargir can be done over the whole surface of a street instead of being

done in spots, and that it is independent of the depth of the asphalt layer.

The heating apparatus which I have arranged for thus effecting the softening of the surface of asphalt roadways is represented on the drawing annexed, in longitudinal and transverse sections, Figs. 1 and 2. It is composed of a box body the sides A, A, B, B, of which are perforated throughout, and the bottom C, whereof, is formed of a grating below which there is a metal plate D, to radiate the heat over the surface of the asphalt. Said plate D is movable to allow for the withdrawal of cinders. The Box is mounted upon the wheels E, the axes *e* whereof are adjustable upon supports *a*, the elevation of which in guides *b* can be varied to augment or diminish the distance of the box to the roadway. A handle F serves to manoeuver the car over the pavement. This system, especially applicable for streets of compressed asphalt, can be equally employed to repair and re-charge streets of bitumen.

Resume:

I claim as my invention, my system for reparation and re-charge of asphalt roadways, presenting as distinctive characteristics the points following:

1st. The softening of the upper surface of the asphalt layer at the part to be repaired, and the removal of such upper surface by means of a toothed scraper which striates the part remaining.

2nd. Re-charging, by the addition upon the surface thus softened, of an asphalt layer of convenient thickness, which is stamped by the usual means.

3rd. The movable furnace which I have combined to such end, according to the conditions described and represented.

Paris, June 11, 1880.

181 Official description of Machines and Processes, etc., Paris, 1886, Vol. XXXVII, 2nd part; Engineering Works, 2; Bridges and Highways, pp. 7, 8.

Patent No. 137,208, Crochet, June 11, A. D. 1880; Process for the Reparation and Re-charging of Compressed Asphalt Roadways.

(Translation.)

This process consists in re-heating the part to be repaired by means of a movable furnace which is shifted about at the surface of the street until such portion decrepitates and becomes friable. The upper part of the asphalt layer and that which has been damaged are taken off by means of iron scraper armed with small teeth which performs the office of rake; said scraper in raising the material forms at the same time upon the part remaining numerous striae which render the surface wrinkled and augment the adherence of the additional over-thickness which constitutes the recharge.

Repeated passage of the movable furnace has had equally for its effect to vaporize the water and humidity which are found in the asphalt pavement at the part to be repaired or re-charged.

After such preparatory operation a convenient depth of asphalt powder is spread and tamped by the ordinary means; because of the softening of the subjacent layer said layer solders itself perfectly to the new coat and forms with it a thickness without break in continuity. Such repair and recharging have not altered the neighboring portions in the slightest.

ANNALES

DES

PONTS ET CHAUSSÉES.

MÉMOIRES ET DOCUMENTS

RELATIFS

A L'ART DES CONSTRUCTIONS

ET AU SERVICE DE L'INGÉNIEUR;

LOIS, DÉCRETS, ARRÊTÉS ET AUTRES ACTES

CONCERNANT

L'ADMINISTRATION DES PONTS ET CHAUSSÉES.

4e SÉRIE.

1864

1er SEMESTRE.

5 8 1 15

PARIS.

DUNOD, ÉDITEUR,

SUCCESSEUR DE Vve DALMONT,

Précédemment Carilian-Goeury et Vve Dalmont,

LIBRAIRE DES CORPS IMPÉRIAUX DES PONTS ET CHAUSSÉES ET DES MINES,

Quai des Augustins, n° 49.

N° 4

NOTE SUR L'ASPHALTE.

Son origine, sa préparation, ses applications.

Par M. Léon MALO, élève de l'École centrale, ancien ingénieur des chemins de fer du Midi.

CONSIDÉRATIONS GÉNÉRALES.

Parmi les produits minéralogiques que la puissante activité industrielle de ce siècle a tirés de l'obscurité pour leur donner un rôle important dans les travaux publics, nul assurément n'est plus digne d'étude que l'asphalte. Prodigué par les anciens dans leurs édifices, comme l'attestent les ruines de Babylone et de Memphis, délaissé ensuite, on ne sait pourquoi, pendant quatre ou cinq mille ans, enfin retrouvé et apprécié par les modernes, l'asphalte a reconquis rapidement la place que les civilisations égyptienne et assyrienne lui avaient faite et que les Romains, si soigneux cependant de leur grande renommée de constructeurs, n'avaient pas su lui conserver.

Depuis une vingtaine d'années, les applications de l'asphalte, limitées auparavant à l'établissement des chapes et à l'étanchement des maçonneries, ont pris une telle extension que l'on doit s'étonner de voir avec quelle indifférence les savants traitent encore ce produit ; c'est à peine si les ouvrages spéciaux lui accordent quelques lignes, et le plus souvent c'est pour en donner, ou une description imparfaite, ou une analyse insignifiante. Plusieurs ingénieurs éminents ont pourtant abordé sérieusement la question, mais dans un but tout

spécial. Ainsi, MM. Darcy et de Coulaine, le premier dans un remarquable rapport sur les chaussées macadamisées de Londres et de Paris (*), le second dans un mémoire des plus intéressants sur l'application des substances bitumineuses aux chaussées (**), ont développé avec beaucoup d'expérience et d'autorité la partie du sujet qui se rapporte à la voirie ; mais leurs travaux sont distancés aujourd'hui par ceux qui s'exécutent en ce moment sous la direction des ingénieurs du service municipal de Paris. M. Henri Fournel, inspecteur général des mines, est peut-être celui qui s'est le plus occupé de l'asphalte, malheureusement une faible partie de ses recherches a été publiée. La monographie de l'asphalte est donc à faire ; nous n'avons point l'intention de l'entreprendre ici, cependant nous croyons qu'on trouvera, dans la note qu'on va lire, l'esquisse de ce qu'il y aurait à écrire sur ce sujet.

Le premier point, c'est d'établir la valeur des définitions et des mots. De cet abandon où la science a laissé jusqu'ici presque tous les produits bitumineux, il est résulté une confusion dans les termes qui nuit singulièrement à la clarté des transactions commerciales. Nous avons pensé qu'un travail comme celui-ci serait avantageusement précédé d'un projet de classification des matières où le bitume entre comme élément utile et nous proposons la suivante qui nous servira dans le courant de cette note.

DÉFINITION ET CLASSIFICATION DES MATIÈRES BITUMINEUSES.

Le principe des matières bitumineuses est un corps complexe dont la composition générale est celle-ci :

$$n(C^{n}H^{y}) + m(C^{n'}H^{y'}O^{x'}),$$

c'est-à-dire un mélange en proportions diverses de plusieurs hydrogènes carbonés simples, accompagnés, dans

(*) *Annales des ponts et chaussées*, 1850, 1er cahier, page 1.

(**) *Annales des ponts et chaussées*, 1850, 2e cahier, page 280.

les variétés solides ou visqueuses, de plusieurs carbures d'hydrogène oxygénés.

L'expression la plus concrète des bitumes est la *houille*.

Carbone	89.31
Hydrogène	4.92
Oxygène et azote	5.77
Houille	100.00 (*)

La plus simple expression connue du bitume est le *naphte*.

Carbone	88.20
Hydrogène	11.80
Naphte	100.00 (**)

Entre ces deux extrêmes se déroule toute la série des bitumes, soit à l'état libre, soit emprisonnés dans des gangues ou matières minérales. Pour faire mieux comprendre notre classification, nous allons la résumer dans le tableau suivant où nous indiquerons les principales formes sous lesquelles le bitume est admis dans l'industrie.

Tableau synoptique des matières bitumineuses.

Bitume :	1° à l'état libre :	1° pur (liquide ou visqueux).	Huile de naphte.
			Pétrole de Gabian, de Baku, etc.
			Malthe de la mer Morte.
			Fontaine de Poix (Auvergne).
		2° impur (solide).	Diverses espèces de houille.
	2° mélangé à une gangue terreuse.		Bitume terreux du Mexique.
			— — de Cuba.
			— — de l'île de Trinidad.
	3° mélangé à une gangue quartzeuse.		Sables bitumineux de Pyrimont-Seyssel.
			— — de Clermont.
			— — de Bastennes, etc.
	4° imprégnant des schistes.		Schistes bitumineux d'Autun.
			— — de Buxières-la-Grue (Allier).
			— — du Dauphiné, etc.
	5° imprégnant des calcaires (asphalte)		Asphalte de Seyssel.
			— du Val-de-Travers.
			— de Lobsann.
			— de Chavaroche.
			— de Clermont, etc.

(*) M. Régnault.
(**) M. Dumas.

Comme on le voit par le tableau ci-dessus, les manifestations du bitume sont nombreuses; sous toutes ses formes il a reçu dans le commerce, l'industrie ou les constructions, des applications considérables, et chaque jour lui en crée de nouvelles. Le produit que nous détachons de cette riche nomenclature pour en faire l'objet de cette étude est, après la houille, celui dont les services sont le plus incontestables, et pourtant à peine sait-on d'où il vient, ce qu'il est avant de s'étendre sur nos trottoirs ou de couvrir nos terrasses; on n'est pas même d'accord sur le nom qu'on doit lui donner.

Il est donc juste et nécessaire de fixer l'individualité de ce corps par une expression invariable qui ne soit plus laissée au hasard des localités ou aux caprices du langage, et nous proposons d'appeler définitivement *asphalte*, non pas, comme font les chimistes, le bitume oxygéné, mais la roche calcaire imprégnée de bitume; cette dénomination est presque partout consacrée par l'usage, elle est en vigueur dans toutes les mines de calcaire bitumineux; enfin son étymologie (ἀσφαλίζω, je fortifie) indique assez que les anciens n'ont jamais entendu l'appliquer au bitume libre, qui, solide ou liquide, est incapable de remplir le rôle de ciment.

Chaque fois que dans les âges géologiques une masse de matières organiques emprisonnée par des obstacles puissants a été soumise à la fois à une forte pression et à une haute température, un *bitume* s'est formé.

Ainsi lorsque des amas de grands végétaux se sont trouvés enfouis sous les terrains de transition et exposés à la chaleur considérable que dut rayonner pendant longtemps l'écorce mal refroidie du globe leur composition s'est modifiée, leur oxygène a presque entièrement disparu, et une matière bitumineuse très-fixe, riche en carbone et en hydrogène, la *houille*, est restée.

On peut voir par la comparaison des deux analyses suivantes quelle transformation s'est opérée à la suite de cette espèce de distillation :

	Cellulose.	Houille.
Carbone	44.44	89.31
Hydrogène	6.18	4.91
Oxygène	49.38	5.77
	100.00 (*)	100.00 (**)

Si, au lieu de végétaux, c'est sur des animaux que cette action s'est exercée, elle a donné naissance à un bitume plus volatil qui tantôt s'est condensé au lieu même de sa formation, tantôt s'est échappé dans l'atmosphère pour aller imprégner, ici des marnes feuilletées comme dans le bassin de l'Allier, là des grès tendres ou des poudingues comme à Bastennes et à Pyrimont, ailleurs des calcaires de la formation jurassique pour produire l'asphalte de Seyssel et du Val-de-Travers.

On pourrait encore mettre en présence les deux analyses ci-dessous pour expliquer la modification moléculaire qu'a éprouvée la matière animale en passant à l'état bitumineux.

	Chair musculaire.	Bitume de Bastennes.
Carbone	62.78	87.00
Hydrogène	6.96	11.20
Oxygène	13.48	1.80
Azote	16.78	»
	100.00 (***)	100.00 (****)

Enfin, quand, par un phénomène dont on retrouve encore aujourd'hui des exemples en plusieurs contrées, le bitume est lui-même exposé à des actions volcaniques souterraines et permanentes, comme à Baku en Perse, il donne dans cette seconde distillation une huile plus ou moins volatile que, lorsqu'elle est pure et incolore, on nomme *naphte*, et que, si elle est souillée de bitume oxygéné, on appelle *pétrole*.

On a soutenu que le bitume pouvait être une matière ignée préexistante à la solidification de la croûte terrestre et condensée en même temps que les roches de fusion; nous

(*) et (**) M. Régnault.
(***) M. Régnault.
(****) M. Boussingault.

ne croyons pas que personne reconnaisse aujourd'hui ce système, les traces organiques sont évidentes dans les gisements bitumineux, et d'ailleurs rien n'est plus facile que de reproduire dans le laboratoire l'opération à laquelle est due la création du bitume.

Ainsi nous admettons qu'à des époques indéterminées, des masses considérables de végétaux ou d'animaux enfouis sous des couches sédimentaires et chauffées soit directement par la chaleur centrale, soit par l'invasion des courants volcaniques, ont dans une immense distillation donné naissance à tous les bitumes. Il est certain que cette action gigantesque s'est exercée d'une manière très-variée; que, selon le lieu, la température, la pression, la nature des roches voisines, l'époque de l'opération, l'espèce des matières premières, le produit obtenu a dû différer de forme, d'aspect, de composition et de propriétés. Mais le mode de formation a été le même partout et les corps résultants renferment un principe identique, le principe *bitumineux*, qui n'est semblable à celui d'aucun autre corps et sur lequel il n'est pas permis de se méprendre.

Nous laisserons de côté le bitume particulier appelé *houille* et ceux qui ont un rôle spécial dans l'industrie, pour ne nous occuper que de l'asphalte et des bitumes qui interviennent dans sa préparation ou dans ses applications. Nous quittons donc les généralités pour entrer dans notre sujet.

DE L'ASPHALTE.

1° *Principaux gisements d'asphalte.* — Le bitume libre est abondamment répandu sur la surface du globe, il se rencontre dans presque tous les terrains volcaniques et imprègne souvent les molasses superposées à la formation jurassique. Ainsi on le trouve en grande quantité et sous les aspects les plus divers aux environs de Clermont-Ferrand, tantôt à l'état de liberté parfaite comme dans la *Fontaine de Poix*, tantôt mé-

lange avec des sables fins comme à Chamalière et Gerzat, tantôt disséminé dans les cavités d'une marne spongieuse comme à Pont-du-Château. La forme la plus ordinaire du bitume libre est celle de mélange avec les sables quartzeux ou molasses vertes de la formation néocomienne ainsi qu'on l'exploite à Pyrimont-Seyssel (Ain) et à Bastennes (Landes) (ce dernier gisement épuisé aujourd'hui). Le bitume libre se montre encore en Judée dans le lac asphaltique; dans la mer Caspienne, surnageant à la surface; aux Antilles (île de la Trinité), souillé d'une base terreuse et solide à la température ordinaire.

Le bitume à l'état de combinaison ou de mélange intime est plus rare; sous l'espèce de schiste, on la rencontre encore assez facilement dans le bassin houiller d'Autun (Saône-et-Loire), dans celui de Buxières (Allier), en Provence, en Dauphiné, dans le Nord et ailleurs; mais sous celle de calcaire on ne compte guère en Europe que trois à quatre mines avantageusement exploitables.

Le schiste bitumineux est la matière première d'une industrie récente et déjà considérable; on en extrait par une double distillation une huile légère et incolore qui défraye l'important commerce des huiles à éclairage minéral; nous n'avons point à nous en occuper dans cette note.

Quant au calcaire bitumineux ou *asphalte* proprement dit, la plus rare des manifestations de bitume, c'est une roche formée de 90 à 94 p. 100 de carbonate de chaux pure, et de 10 ou 6 p. 100 de bitume. Son aspect est celui de la pierre à plâtre, sa couleur celle du chocolat foncé; lorsqu'on la coupe, la surface entamée présente cette apparence blanchâtre que le couteau laisse aussi sur le chocolat; le grain est fin, et lorsqu'on en examine attentivement la structure, on reconnaît que chaque molécule de calcaire est environnée d'une couche presque atomique de bitume; tout grain est ainsi isolé de son voisin par un vernis qui sert en même temps à les coller énergiquement l'un à l'autre. Pendant

les chaleurs, ce vernis devient visqueux et souvent le poids seul d'un bloc suffit pour le rompre en deux ou plusieurs fragments; dans l'hiver, au contraire, le bitume devient sec et la roche prend une dureté remarquable.

Les gisements d'asphalte se comptent; la nature s'est montrée avare de cette précieuse matière et l'on ne saurait guère déterminer par quelle loi les gîtes les plus riches connus, on peut dire les seuls exploitables, se trouvent presque réunis dans une zone très-resserrée de la carte d'Europe. On voit en effet que si l'on tire une ligne droite du nord au sud, depuis Wissembourg jusqu'à Chambéry, cette ligne traversera les quatre mines qui défrayent aujourd'hui l'industrie des dallages : Lobsann, le Val-de-Travers, Seyssel et Volant, enfin Chavaroche. Il n'entre point dans le cadre de cette note de développer les conclusions qu'on pourrait tirer d'une telle situation géographique ainsi que de la coïncidence de cette ligne avec la direction des monts Jura, ce serait entrer dans une discussion trop pleine d'hypothèses. Nous ne nous étendrons pas non plus sur le mode probable d'imprégnation des calcaires bitumineux, les avis sont partagés sur ce point; quelques-uns veulent qu'à la suite des distillations souterraines dont nous avons parlé plus haut, les vapeurs se soient répandues dans l'atmosphère et frayé un passage à travers les fentes des roches dures pour aller se loger dans les roches tendres; d'autres préfèrent que les bitumes libres de Judée ou d'autres pays éloignés soient venus, véhiculés à la surface des eaux par un déluge universel, imprégner à froid les calcaires. De graves objections, tirées de la structure même de la matière, peuvent être opposées à l'un et à l'autre de ces systèmes; l'origine de l'asphalte doit donc, jusqu'à ce que de nouvelles études aient été faites, rester dans le doute.

Quoi qu'il en soit de sa formation, le banc d'asphalte, qui paraît être du même âge dans les quatre gisements que nous avons cités, appartient à la partie supérieure du ter-

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rain jurassique et se trouve situé immédiatement au-dessous des molasses vertes.

Outre les mines précédemment indiquées, il existe dans plusieurs régions de la France et de l'Espagne des affleurements de calcaire bitumineux de richesse très-inférieure et de pureté douteuse.

2° *Extraction, pulvérisation, tamisage.* — On exploite l'asphalte à la manière du moellon avec la poudre et la barre-à-mine; souvent la roche est assez tendre pour qu'on puisse pratiquer les trous de mine à la tarière. L'extraction s'opère, soit à ciel ouvert comme à Pyrimont-Seyssel et au Val-de-Travers, soit sous galerie comme à Volant et à Chavaroche.

Les moellons d'asphalte sont empilés sur le carreau de la mine par tas de 100 mètres cubes; une partie est expédiée sur les travaux à l'état de roche, le reste est envoyé aux usines de fabrication du mastic. On a soin ordinairement d'éviter les grands approvisionnements en été, parce que les chaleurs font décrépiter la roche, qui tombe d'elle-même en poussière. Cet inconvénient cesse si les approvisionnements sont emmagasinés dans les galeries. L'été est aussi la saison la plus redoutée des mineurs qui travaillent à ciel ouvert; sous l'action du soleil, le banc d'asphalte se ramollit au point que les coups de mine sont sans effet et qu'on est obligé de se contenter du pic, du levier et du coin. Les frais de main-d'œuvre doublent quelquefois de l'hiver à l'été.

La roche destinée à la fabrication du *mastic* est concassée, puis pulvérisée.

Cassage. — Le cassage de la roche est un travail simple, mais qui ne laisse pas de prendre une certaine importance dans l'ensemble des opérations, par suite d'une circonstance spéciale, que nous avons déjà signalée plus haut. Nous avons dit que l'asphalte, très-dur en hiver, se ramollit considérablement dans les chaleurs; il en résulte que le cas-

sage, facile dans les froids, devient très-laborieux en été, impossible même quelquefois lorsque les blocs à débiter ont été exposés à un soleil ardent. Sous l'action du soleil, le bitume d'imprégnation se liquéfie, la matière devient lâche et le casseur ne frappe plus que sur une espèce de pâte qui s'aplatit sans se fendre. Aussi évite-t-on d'avoir ce travail à faire en été, à moins qu'il ne s'effectue dans les galeries mêmes où s'extrait la roche. On peut admettre qu'en moyenne la main-d'œuvre de cassage du calcaire bitumineux varie de l'hiver à l'été dans le proportion de 3 à 5.

La roche est cassée ordinairement à la grosseur des cailloux qui servent à l'empierrement des routes; elle est enmétrée pour le toisage; on trouve qu'un tas de roche en bloc, transformée en roche cassée, perd environ 20 p. 100 de son volume.

Le calcaire bitumineux cassé est ensuite pulvérisé, puis tamisé

La pulvérisation peut s'opérer de deux manières :

A chaud, par la décrépitation ;

A froid, par l'écrasement.

Pulvérisation à chaud. — La roche cassée est placée dans des caisses découvertes en tôle mince de $1^{m}.00 \times 0.60 \times 0.20$. Ces caisses sont introduites dans des cornues plates en fonte, analogues aux cornues horizontales employées à la distillation des schistes bitumineux; on entretient sous ces appareils une chaleur douce et uniforme; le phénomène suivant se produit : le bitume dont la roche est imprégnée, solide à la température ordinaire, se ramollit et se fond; les molécules calcaires se séparent les unes des autres et tombent en poussière. On secoue les caisses de temps en temps pour présenter successivement toutes les parties d'asphalte à l'action de la chaleur, puis on verse la matière ainsi *étonnée* sur une aire plane où on la pilonne, afin d'achever la pulvérisation; enfin, on la passe au tamis qui retient certaines parties plus résistantes nommées *grabons*; ces grabons sont

écrasés à part à coups de maillet et restitués au tamis. La poudre obtenue est apte à être transformée en mastic.

On produit aussi la décrépitation dans des appareils spéciaux, dont nous parlerons à propos des chaussées en roche d'asphalte comprimée.

La pulvérisation par décrépitation, telle que nous venons de la décrire, est le premier système qui ait été employé; elle présente ce grand avantage de n'exiger aucun moteur, mais elle paye cet avantage par de nombreux inconvénients. S'il était possible de soumettre toutes les parties de la matière à une température uniforme et qui se maintint constamment entre le point de ramollissement du bitume d'imprégnation et celui de son évaporation, nul système ne serait préférable assurément; mais cette condition, qu'on obtiendrait peut-être dans un laboratoire avec une attention soutenue, est presque impossible à réaliser dans la pratique; Quelque soin qu'on y apporte, on dépasse toujours la température de volatilisation, et on perd ainsi une certaine quantité de bitume qu'il faut restituer ensuite artificiellement; d'autre part, toute la matière ne pouvant être également chauffée, on n'arrive à la décrépitation des parties intérieures qu'en brûlant celles qui touchent aux surfaces de chauffe.

La pulvérisation par décrépitation est donc dans l'état actuel de sa pratique une opération essentiellement défectueuse; on n'y doit avoir recours que lorsqu'on ne peut pas faire autrement, c'est-à-dire toutes les fois qu'on n'a pas une force motrice suffisante à sa disposition. Cependant on ne peut nier que l'idée de réduire en poudre le calcaire par le simple ramollissement de ses huiles d'imprégnation est une idée séduisante, et l'on ne saurait être surpris de voir que, même encore aujourd'hui, elle n'est pas complétement abandonnée; on y reviendra certainement le jour où l'on sera parvenu à chauffer uniformément et méthodiquement la roche de façon que la température reste toujours infé-

rieure au point où le bitume prend l'état de vapeur. C'est un appareil à trouver (*).

Cependant la poudre employée à l'établissement des chaussées en asphalte comprimé s'est jusqu'à présent obtenue par la décrépitation. Nous reprendrons cette question en son lieu.

Pulvérisation à froid. — Dans les usines où le mastic d'asphalte se prépare en grand, on pulvérise la roche à froid.

On emploie deux espèces d'appareils :

Le molleton,

Le moulin à noix.

Le premier système n'est autre que la meule verticale en pierre ou en fonte, munie du racloir et des autres accessoires que l'on voit partout.

Le second représente assez bien le moulin à café ordinaire en grande dimension; c'est un cône en fonte de $0^m.60$ à $0^m.70$ de base et de $0^m.80$ de hauteur, monté sur un arbre vertical et se mouvant dans une coquille de même métal, le cône et la coquille sont garnis de dents qui brisent la pierre et la réduisent en poussière.

Au sortir du moulin, la poudre tombe dans des blutoirs cylindriques à maille de $0^m.02$ environ; la poudre tamisée est bonne à être livrée à la cuisson, les grabons sont rendus aux moulins.

3° *Cuisson.* — Pour fabriquer le mastic d'asphalte tel qu'il est employé dans les travaux, on fait subir à la roche une cuisson dans les conditions suivantes :

On se sert de chaudières demi-cylindriques en fonte de 2 mètres de longueur sur 1 mètre de diamètre placées horizontalement sur des fourneaux à retour de flamme. Un

(*) Depuis quelques mois seulement, on emploie un moyen qui paraît être la solution du problème et qui consiste à introduire un jet de vapeur dans un cylindre où l'on renferme la roche; sous cette action, la roche tombe en poussière au bout de 10 minutes. Les applications de ce système sont à l'étude.

arbre fixé dans l'axe du cylindre et porteur de lames dirigées dans le sens du rayon agite la pâte et en met successivement toutes les parties en contact avec la surface de chauffe; chaque appareil est surmonté d'un couvercle en tôle, demi-cylindrique aussi, qu'on soulève de temps à autre pour introduire la matière et surveiller la marche de l'opération; enfin, des tuyaux de dégagement sont adaptés aux flancs des chaudières pour écouler les vapeurs d'eau qui s'échappent abondamment au commencement de la cuisson.

On jette d'abord dans chaque chaudière 90 à 100 kilogrammes de bitume libre qui entre bientôt en fusion; quand il a atteint à peu près sa température de volatilisation, on met l'agitateur en mouvement et l'on jette pelletée par pelletée la poudre d'asphalte; la poudre en tombant dans le liquide chaud décrépite et se mélange intimement avec lui; on continue l'introduction jusqu'au moment où le mélange va cesser d'être pâteux pour devenir friable, ce qu'on reconnaît à ce que la matière commence à s'attacher au fond de la chaudière et aux lames de l'agitateur. A cet instant, l'appareil a reçu environ :

100 kilogrammes de bitume libre;

1 400 kilogrammes de poudre d'asphalte.

Après avoir chauffé et agité pendant six heures, on procède à la coulée.

On coule le mastic dans des moules cylindriques composés chacun d'une tôle recourbée en demi-cercle, de façon à former des pains de $0^m.30$ de diamètre sur $0^m.10$ à $0^m.12$ de hauteur et pesant 25 kilogrammes environ. Une marque de fabrique, incrustée dans l'une des tôles, imprime son relief sur chaque pain pour attester son authenticité; ce sont ces pains qui, expédiés sur les travaux, sont refondus dans les chaudières ambulantes pour l'établissement des trottoirs ou autres ouvrages d'asphalte.

Que se passe-t-il pendant cette période de la cuisson? Quelle modification s'opère dans les éléments de l'asphalte? Par suite de quelle métamorphose la roche bitumineuse devient-elle un mastic puissant, facilement fusible et si différent de sa matière première? Il est bien difficile de le connaître. Le bitume libre qu'on ajoute est évidemment absorbé par celui déjà logé dans les pores du calcaire; véhiculé par lui, il pénètre jusque dans les plus intimes cavités de l'asphalte, comme une goutte d'huile suit le chemin tracé par une autre goutte; mais on ne saurait prétendre que le bitume libre apporte avec lui des propriétés nouvelles; ses fonctions sont purement accessoires; il aide à la fusion de la roche; il supplée aux huiles imprégnantes perdues par l'évaporation, il prépare la pâte pour la trituration et la cuisson, comme la salive, si l'on veut nous permettre cette comparaison, humecte les aliments, les dispose pour la mastication et favorise leur transformation.

Quoi qu'il en soit de cette action du bitume ajouté, il est un fait constant, c'est que plus ce bitume a d'analogie géologique avec celui dont la roche est imprégnée, meilleur est le mastic obtenu. Nous dirons ailleurs quelle peut être l'influence de ce plus ou moins de ressemblance sur la durée des ouvrages en asphalte.

Le mastic fabriqué avec de la roche abondamment et également imprégnée, fine de grain, additionnée d'un bitume à peu près congénère, est un corps noir à reflets rougeâtres, élastique, infusible au soleil le plus ardent et doué d'une odeur bitumineuse presque agréable. Nous reviendrons sur ses propriétés spéciales quand nous parlerons de ses applications.

4° *Extraction et préparation des bitumes qui interviennent dans la fabrication du mastic.* — On vient de voir que le bitume libre joue un rôle important dans la fabrication du mastic d'asphalte; il en remplit un autre non moins sérieux lors de son application; nous ne pouvons donc nous dis-

penser d'entrer, avant d'aller plus loin, dans quelques détails à son sujet.

Ainsi que nous l'avons dit plus haut, le bitume se rencontre, soit à l'état de liberté absolue, soit, et le plus ordinairement, agglutinant des sables quartzeux, soit enfin mélangé avec des matières marneuses ou terreuses.

Dans le premier cas, dont la *fontaine de Poix* est un exemple, on se borne à recueillir le bitume à sa sortie de terre, à le purger par un simple raffinage de toutes les impuretés dont il peut être souillé, et l'on obtient ainsi un corps visqueux d'un beau brillant noir, le *bitume* pur, en un mot.

Dans le second cas, on exploite, comme à Pyrimont-Seyssel, à Bastennes ou à Clermont, des bancs très-irréguliers de molasse saturée de bitume ; les blocs qu'on extrait sont cassés en morceaux de $0^m.07$ à $0^m.08$ de côté, jetés dans des chaudières pleines d'eau bouillante et brassés pendant une heure environ. Le bitume porté à 100 degrés se liquéfie, la molasse tombe en sable et le bouillonnement de l'eau agissant mécaniquement, chaque grain se dépouille de son enveloppe bitumineuse qui vient surnager ; on écume la surface pour recueillir le bitume, et le sable reste blanc au fond ; on enlève ce sable, on recharge la chaudière et l'opération recommence. Lorsque la molasse est à gros grain, comme on en trouve à Lussat (Auvergne), le sable est complétement précipité et le bitume est presque pur ; mais il est fort rare que la molasse ne soit pas très-fine de grain, et alors la matière enlevée à l'écumoir renferme toujours une grande quantité de grès désagrégé entraîné par l'ébullition et disséminé dans le bitume. Pour purger les écumes de ce sable, on les fait bouillir, l'eau s'évapore, le sable gagne le fond en vertu de sa densité et l'on décante. Le bitume obtenu par cette seconde opération est absolument pur, mais le sable resté au fond de la chaudière en conserve encore un volume presque égal au sien et qu'il est impossible

de lui retirer pratiquement. Ce système d'extraction, dispendieux et barbare, a été décrit par d'Alembert (*) tel qu'on l'emploie encore aujourd'hui ; il n'a pas fait un pas depuis cent ans. Cependant de nouveaux procédés sont à l'étude ; quoiqu'ils n'aient pas encore donné les résultats espérés, on peut prévoir qu'il sera bientôt possible de supprimer des méthodes aussi en arrière des progrès de l'industrie.

Dans le troisième cas, celui où le bitume est mélangé avec des matières terreuses, on est obligé d'avoir recours à d'autres moyens ; les bitumes de la Trinité, par exemple, s'étendent en immenses lacs desséchés, dont le fond est entièrement composé d'une sorte de roche noirâtre, qui n'est autre que le bitume solidifié par la présence des matières étrangères et par l'évaporation d'une certaine quantité d'huiles essentielles. On extrait cette roche que l'on transporte en France, où on la soumet au traitement suivant : on distille une partie de ce bitume solidifié et l'on obtient au serpentin une huile bitumineuse analogue aux huiles lourdes de schiste ; cette huile sert à dissoudre dans des chaudières spéciales trois autres parties de bitume solide. La dissolution se fait à chaud ; les gangues terreuses plus denses vont au fond, et par un décantement, on en sépare le bitume pur, qu'on embarille et qu'on expédie sur les travaux.

En général, toutes les matières bitumineuses, calcaire, schiste, sable, roche solide de la Trinité, donnent à la distillation le même produit, un carbure d'hydrogène multiple oxygéné, le *pétrole* des anciens ; quelquefois l'arome varie, le bitume de Clermont, par exemple, exhale une forte odeur alliacée qu'on ne retrouve point ailleurs ; mais chez tous, l'aspect, la composition, la combustion, sont sensiblement identiques ; on a donc été conduit à substituer dans certains cas, et lorsqu'on a trouvé économie à le faire, les différentes huiles les unes aux autres. Ainsi, dans l'opération qui

(*) Encyclopédie. — Article *Asphalte*.

consiste à dissoudre le bitume brut de la Trinité dans sa propre huile de distillation, on a pu remplacer cette huile par celle qu'on obtient en distillant les schistes bitumineux.

Les principales espèces de bitume qui servent, soit dans la fabrication, soit lors de l'application du mastic asphaltique, sont celles que nous venons d'énumérer; nous les rappelons :

Le bitume natif (Clermont);

Le bitume provenant du lessivage des molasses (Pyrimont-Seyssel, Bastennes, Bœchelbronn, etc.);

Le bitume de la Trinité épuré.

En dehors de ces trois espèces, on emploie encore :

Le bitume provenant de l'épuration des huiles lourdes de schiste;

Le bitume résidu de la distillation de la houille;

Les bitumes mixtes dits bitumes de suif.

On utilise sans désavantage les bitumes de schiste lorsqu'ils ne sont pas trop concentrés; leur composition est à peu près la même que celle des bitumes naturels, et s'il n'était pas très-difficile de les obtenir toujours semblables à eux-mêmes, nous ferions peu de différence entre leur usage et celui des meilleurs bitumes naturels. Quant aux bitumes ou *goudrons* de houille et de *suif*, on doit en proscrire, autant que possible, la présence dans les ouvrages d'asphalte de mince épaisseur. Le bitume de houille, appelé aussi *goudron de gaz*, rend le mastic cassant en hiver et mou en été, il répand à l'application une odeur insupportable; enfin, ses huiles essentielles, étant très-volatiles, s'évaporent promptement au contact de l'air, les dallages, dans la composition desquels il entre, deviennent friables et s'usent promptement lorsqu'ils ont une circulation fréquente à supporter. Le bitume de suif, plus encore peut-être que celui de houille, est à redouter dans les travaux. Les éléments graisseux qu'il renferme, loin de s'unir au bitume d'imprégnation de l'asphalte, le dissolvent au contraire,

et en font une pâte malléable qui se détruit rapidement sous les pieds des passants. L'un et l'autre de ces bitumes sont incapables de constituer de bons trottoirs, et si leur bas prix les fait encore admettre par quelques entrepreneurs, ils doivent être sévèrement interdits par les architectes et les ingénieurs.

5° *Application de l'asphalte.* — Les applications de l'asphalte sont indéfinies; notre dessein n'est ni ne décrire toutes celles qui sont trouvées, ni d'indiquer celles qui restent à découvrir: ce serait le fait d'un traité spécial; nous nous bornerons à signaler les principaux usages qu'on en fait, soit dans la voirie, soit dans les travaux hydrauliques, et nous suivrons, comme le plus logique, l'ordre que voici :

I. Application de l'asphalte brut.

II. Application du mastic d'asphalte.

I. Application de l'asphalte brut.

Chaussées en asphalte comprimé. — Dès l'origine de l'asphalte, on put lui reconnaître la propriété suivante : les charrettes qui transportaient la roche de la mine aux lieux de traitement (*) laissaient souvent tomber sur le chemin des fragments que les roues écrasaient. Lorsque la route était couverte de ces débris, l'été survenait, la chaleur ramollissait le bitume d'imprégnation, les voitures qui se succédaient comprimaient la matière, et il se formait une croûte solide, dense, élastique, facile aux pieds des chevaux et d'une usure presque nulle. Nous avons vu, dans presque toutes les mines d'asphalte, de semblables chaussées, et l'on en peut remarquer une à Pyrimont-Seyssel, dont les vestiges, encore robustes, malgré le système barbare d'enrayage en vigueur dans le pays, sont âgés aujourd'hui de près de soixante ans.

(*) Avant que l'on songeât à appliquer l'asphalte à l'établissement des trottoirs et des chaussées, on le distillait pour en obtenir une huile d'éclairage, analogue à l'huile de schiste.

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Ce n'est que vers 1850 qu'on mit volontairement à profit cette leçon du hasard. Un ingénieur suisse, M. Mérian, établit à cette époque, dans le petit village de Travers (canton de Neufchâtel), une chaussée en roche d'asphalte chauffée et comprimée. Dans l'expérience de M. Mérian, l'asphalte était simplement répandu sur la chaussée macadamisée et soumis au rouleau ; malgré l'instabilité de l'assiette et l'irrégularité de l'entretien, la route de Travers est encore en assez bon état.

La même année, M. Darcy, inspecteur général des ponts et chaussées, au retour d'une mission spéciale à Londres, publiait dans les *Annales* un long et savant mémoire où, après avoir exposé et discuté tous les systèmes employés à Londres et à Paris, il déclarait que la solution du problème était « *dans l'emploi de la roche asphaltique posée à froid.* » Les expériences faites à Paris dans ce sens ne donnèrent cependant que des résultats incomplets ; on y renonça. Un ingénieur aussi compétent en matière de voirie que l'était M. Darcy ne pouvait se tromper à ce point ; aussi a-t-il été reconnu plus tard que sa seule erreur fût d'avoir prescrit l'emploi de l'asphalte *froid*. La roche d'asphalte chauffée, pulvérisée par la décrépitation, établie sur la forme de la chaussée, pilonnée et comprimée au rouleau, reprend par le refroidissement l'état où elle se trouvait dans ses gisements ; c'est ce qui fait sa force, son élasticité, son homogénéité, sa *solidarité*. On ne peut évidemment pas arriver au même but avec la roche asphaltique posée à froid.

Vers la même époque, un autre ingénieur distingué du corps des ponts et chaussées, M. de Coulaine, faisait, sur le pont de Saumur et sur les routes du département de Maine-et-Loire, des essais analogues, dont il rendit compte aussi dans les *Annales*.

Enfin, il y a six ans environ, la chaussée, en asphalte comprimé, obtint son entrée au théâtre obligé de toute expérience sérieuse : elle pénétra dans Paris.

Son premier pas fut fait rue Bergère, le long du Conservatoire de musique, après quoi on attendit quatre ans le résultat. Le résultat fut tel que vers la fin de 1858 la place du Palais-Royal, le point le plus fatigué de tout Paris, fut désignée par l'administration pour être macadamisé en asphalte; depuis ce moment nombre de rues ont échangé leur pavé contre le nouveau système, et rien ne donne à supposer que ce succès doive se ralentir. C'est à MM. Homberg, ingénieur en chef, Vaudrey et Veyssières, ingénieurs ordinaires du service municipal de Paris, que sont dues cette belle étude et ces remarquables applications.

Voici comment on procède pour l'installation des chaussées en asphalte comprimé :

La roche asphaltique, extraite de ses gisements et cassée à la grosseur des cailloux qui servent à l'empierrement des routes macadamisées, est décrépitée comme nous l'avons indiqué plus haut (*), mais dans des appareils spéciaux qui consistent en de grandes caisses de tôle soutenues sur des pieds en fer et sous lesquelles est placé un fourneau; on transporte ces appareils sur le lieu du travail, ou dans un terrain proche, afin de faire perdre à la poudre décrépitée le moins de chaleur possible. La forme de la chaussée a été préalablement recouverte d'une couche de béton dont l'épaisseur est ordinairement de $0^{m}.10$, mais varie avec la solidité du sol. Sur certains terrains, comme les bonnes routes macadamisées et bien entretenues, on pourrait arriver à supprimer entièrement le béton; sur d'autres, où la terre est mal tassée, on est obligé de le porter à $0^{m}.15$. Sur ce béton bien damé, nettoyé et réglé suivant la pente exigée (**), on répand la matière décrépitée que l'on pilonne

(*) A l'article *Pulvérisation*, page 78.

(**) Le bombement de la chaussée doit être extrêmement faible; il ne faut pas qu'il dépasse celui strictement nécessaire à l'écoulement des eaux; avec les chaussées en asphalte comprimé, il est un

et dont on fait une couche de $0^m.04$ ou $0^m.05$, selon la circulation qu'elle doit supporter. On régularise ensuite la compression en promenant sur la surface un rouleau du poids de 2500 à 3000 kilogrammes; deux heures après, la chaussée peut être livrée aux voitures.

La chaussée en asphalte ainsi construite présente une surface unie, douce au roulage des voitures, facile au tirage des chevaux, absorbant complétement le bruit des roues; la boue ni la poussière ne s'y produisent, parce que l'asphalte ne s'use qu'imperceptiblement (*), et si l'on en voit quelquefois sur les chaussées établies à Paris, c'est que ces chaussées étant presque toutes de faible longueur, la poussière et la boue y refluent des pavés voisins; l'abolition de ces deux fléaux (la poussière surtout si redoutable aux étalages des magasins) assurera à elle seule le succès du système. L'imperméabilité de la couche bitumineuse est aussi une précieuse propriété, elle protége le terrain sous-jacent et supprime une cause d'insalubrité que le pavé porte toujours avec lui: les joints du pavé emmagasinent sans cesse les matières organiques que les détritus des habitations et les eaux ménagères leur fournissent; ces matières fermentent, se putréfient et l'action du soleil en répand les miasmes dans l'atmosphère au grand dommage de l'hygiène publique. On pourrait ajouter à ces avantages : la fonte

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inconvénient qu'on ne peut éviter, mais qu'il faut réduire autant que possible; c'est à lui qu'on doit les seuls accidents qui s'y soient produits. A Lyon, où le bombement des chaussées en asphalte comprimé a été fait le même que celui des chaussées pavées, des chevaux de cavalerie se sont abattus, et l'autorité militaire, sans tenir compte des causes de l'accident ni de l'opinion des ingénieurs, a exigé la démolition du travail. A Marseille, au contraire, où la chaussée en asphalte a été établie presque plate, aucun accident n'est arrivé, et cependant toute la circulation entre la ville et le port de la Joliette, la plus énorme circulation qui soit, passe dessus.

(*) On a pu calculer que l'usure moyenne était environ d'un millimètre par an.

rapide des neiges, la simplicité de l entretien et l'absence complète d'ébranlement dans les constructions riveraines.

Il est certain que les chaussées en asphalte comprimé sont des chaussées de luxe et que les villes d'une certaine importance peuvent seules se les permettre; mais les avantages en sont si nombreux et si incontestablement établis aujourd hui que toutes les rues fréquentées des villes de province sont désignées d'avance pour en recevoir l'application. La question de prix est d'ailleurs moins difficile à aborder qu'elle ne semble de prime abord, car la chaussée en asphalte coûte de premier établissement un tiers moins que le pavé de petit échantillon, et d'entretien près de trois quarts moins que le macadam des boulevards de Paris (*).

Ruisseaux en asphalte comprimé. — Dans les rues en pavé, les eaux qui s'écoulent sur les deux versants de la chaussée viennent se réunir dans l'angle rentrant que forme chaque versant avec la face verticale de la bordure du trottoir, et de là se rendent aux bouches d'égout. Quelquefois cet angle est muni d'une pierre concave nommé *caniveau*. qui règne le long de la bordure et forme souvent une seule pièce avec elle.

Le ruisseau en *caniveau* de pierre est cher; le ruisseau

(*) Depuis que cet article a été écrit, un incident s'est produit que nous ne pouvons passer sous silence. Vers le milieu de l'hiver dernier, la chaussée de la rue Neuve-des-Petits-Champs a été entièrement reconstruite en asphalte comprimé; au bout de quelques jours, des fissures et des flâches nombreuses se sont manifestées d'un bout à l'autre de la rue. Ces accidents, qu'on n'avait encore constatés nulle part, ont surpris les ingénieurs qui ont voulu en découvrir la cause; on a démoli la chaussée et on a reconnu que l'asphalte avait été posé sur un béton tellement humide, que l'eau vaporisée par la chaleur de la poudre avait pénétré la couche asphaltique et rompu complétement sa ténacité. La chaussée a été reconstruite en entier et s'est depuis parfaitement comportée

(L. M., avril 1861.)

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en pavé est malsain, nous avons dit plus haut pourquoi. On a essayé de substituer au caniveau en pierre un caniveau en asphalte, c'est-à-dire qu'on a remplacé les deux ou trois derniers rangs de pavé voisins de la bordure par une rigole en roche d'asphalte comprimé à chaud par le même procédé que nous avons décrit pour les chaussées; en un mot, au lieu de couvrir la chaussée entièrement en asphalte, on ne couvre que deux bandes longitudinales qui servent de caniveau. Ce système a été employé l'année dernière pour la première fois à Bordeaux, rue Huguerie.

Les caniveaux en asphalte coûtent, suivant qu'ils sont établis plus ou moins proche des mines d'asphalte, d'un tiers à moitié des caniveaux en pierre.

II. Application du mastic d'asphalte.

Trottoirs. — La plus considérable de toutes les applications de l'asphalte est la confection des trottoirs. On ne peut pas citer, croyons-nous, d'innovation dont le premier succès ait été plus bruyant et que la spéculation ait plus audacieusement exploité; les catastrophes financières dont elle fut la cause involontaire sont devenues proverbiales, et les immenses services rendus par elle à l'industrie et aux travaux publics n'ont jamais pu faire oublier le bruit qui s'est fait autour de son nom et les désastres qui ont accompagné ses premiers pas.

C'est qu'en effet, avant l'asphalte, le trottoir n'existait pas; car il n'était pas permis d'appeler *trottoirs* les choses sans nom sur lesquelles on circulait à Paris, non plus que l'affreux pavé pointu réservé aux piétons dans toutes les villes du midi. L'apparition de l'asphalte fut donc un bienfait, et l'on ne doit point s'étonner de l'accueil exagéré qui lui fut fait; mais l'excès même de cet accueil nuisit singulièrement au nouveau système, non point à Paris où il fut répandu dès le premier moment avec prodigalité, non point à

209 BRIDGE AND HIGHWAY ANNALS.

Memoirs and Documents Relative to the Art of Construction and to the Duty of the Engineer; Laws, Decrees, Orders and Other Acts Concerning the Administration of Bridges and Roads. 4th Series, 1861, 1st Semester.

Paris, Dunod, publisher, successor of V. Dalmont, formerly Carilian—Goenry and Vor Dalmont, Imperial Book-store of the Bridge, Road and Mine Corps No. 49 Augustins Quay.

No. 4. "Note upon Asphalt: Its origin, its preparation, its applications."

By Leon Malo, graduate of the Central School, former engineer of the Midland Railways.

Translations (p. 69): General considerations. Amongst the mineralogical products which the puissant industrial activity of this cycle has drawn from obscurity to assign to them an important role in public constructions, none—assuredly—is more worthy of study than asphalt. Prodigally used by the ancients in their edifices, as the ruins of Babylon and of Memphis attest, abandoned later—one knows not why—for four or five thousand years, finally re-found and appreciated by the moderns, asphalt has rapidly re-
conquered the place which Egyptians and Assyrian civiliza-
210 tion had given it and which the Romans, so careful nevertheless of their great renown as constructors, had not been able to conserve for it.

For a score of years the applications of asphalt limited, previously to the fixing of copes and the stanching of masonry (i. e., rendering it water tight), have taken such an extension that one is astonished to see with what indifference the learned still treat this product. It is with difficulty that special treatises accord it a few lines and most often it is to give the subject either an imperfect description or an insignificant analysis. Several eminent engineers have, nevertheless, seriously attempted the question, but with a wholly special aim. Thus, Messrs. Darcy and de Coulaine, the first in a remarkable report upon the macadamized roads of London and of Paris,* the second in a memoir of the highest interests upon the application of bituminous substances to streets, **have devel-

* Bridge and Highway Annals, 1850, 4th quarter p. 1.

** Bridge and Highway Annals, 1850, 2nd quarter, p. 240.

oped with much experience and authority that part of the subject which pertains to public highways; but their labors are distanced to-day by those which are carried on at the present time under direction of the engineers in the Municipal Service of Paris. Mr. Henry Fournel, inspector general of mines, is perhaps the one who has most occupied himself about asphalt; unfortunately, only a slight part of his researches have been published. The monograph on asphalt is yet to be made; we have no intention to undertake it here, although we believe that there will be found in the following note the essence of that which has been written upon this subject.

211 The first point is to establish the value of definitions and of words. By that desertion wherein science has thus far left nearly all bituminous products there has resulted a confusion in terms which is singularly injurious to the clarity of commercial transactions. We have thought that a work such as this present might be advantageously preceded by a project for the classification of them aterials wherein bitumen enters as a useful element and we propose the following which will serve us in the course of this note:

Definition and Classification of Bituminous Materials: The basis of bituminous materials is a complex body, the general composition of which is this:

$$n\,(Cx.\ Hy) - m\,(Cx,\ Hy,\ Oz)$$

that is to say a mixture in divers proportions of several simple hydro-carbons, accompanied in the solid or viscid varieties by several oxygenated hydro-carbons. The most concrete expression of the bitumens is coal.

Carbon	89.31
Hydrogen	4.92
Oxygen and nitrogen	5.77
Coal	100.00 *

The most simple known expression of bitumen is naphtha.

Carbon	88.20
Hydrogen	11.80
Naphtha	100.00**

* Mr. Regnault.

** Mr. Dumas.

Petween these two extremes is displayed the whole series
212 of bitumens, whether in free state or imprisoned in minerals or gangues. To better comprehend our classification we proceed to summarize it in the following table wherein we indicate the principal forms under which bitumen is admitted (i. e., comes) into industry:

Bitumen:	1. In free state:	1. Pure (liquid or viscid).	Naphtha oil. Petroleum, of Gabian, Baku, etc.
			Maltha, from Dead Sea. Fountain of Pitch (Auvergne).
		2. Impure (solid).	Various species of coal.
	2. Mixed with an earthy gangue:		Earthy bitumen of Mexico. Earthy bitumen of Cuba. Earthy bitumen of Trinidad.
	3. Mixed with a quartz gangue:		Bituminous sands of Pyrimont-Seyssel. Bituminous sands of Clermont. Bituminous sands of Bastennes, etc.
	4. Impregnating schists:		Bituminous schists of Anton. Bituminous schists of Buxieres-la-Grue (Allier). Bituminous schists of Dauphiny, etc.
	5. Impregnating limestone (asphalt):		Asphalt of Seyssel. Asphalt of Val-de-Travers. Asphalt of Lobsann. Asphalt of Chavanche. Asphalt of Clermont, etc.

As can be seen by the above table the manifestations of bitumen are numerous; under all of its forms it has received in commerce, industries or constructions some considerable applications and each day gives rise to new ones. The product that we detach from this rich nomenclature to make the object of this study is, after coal, that whereof the services are the most incontestable, and although one scarcely knows from what it comes that is it which extends far over our sidewalks or covers our levelled roadways (terraces); there is even no accord about the name which one shall give it.

It is then just and necessary to fix the individuality of this
213 body by an invariable expression which leaves it no longer to the hazards of locality nor to the caprices of language, and we propose to call definitely Asphalt not oxygenated bitumen, as the chemist do, but lime rock impregnated with bitumen; this designation is almost wholly sanctioned by usage, it is in vigor at all the mines of bituminous limestone, finally, its etymology (Asphaleto, I fortify) indicates sufficiently that the ancients had never

intended to apply it to the free bitumen which, solid or liquid, is incapable of filling the role of cement.

In the geologic ages, as often as a mass of organic material imprisoned by powerful obstacles was subjected at once to a strong pressure and to a high temperature, a bitumen was formed.

Thus when heaps of vast vegetations chanced to be buried beneath strata of transition and to be exposed to the considerable heat which was bound to irradiate for a long while the poorly chilled crust of the globe their composition became modified, their oxygen had almost entirely disappeared and a very stable bituminous material rich in carbon and in hydrogen—coal—remained.

It can be seen by comparison of the two analyses following what transformation operated in the course of such a species of distillation:

	Cellulose.	Oil.
Carbon	44.44	89.31
Hydrogen	6.18	4.92
Oxygen	49.38	5.77
	100.00*	100.00**

If instead of vegetation it were upon animal remains that such action was exercised, it had given birth to a more volatile
214 bitumen which at times was condensed at the very place of its formation, at times escaped into the atmosphere to impregnate it; herein the marl beds as in the basin of the Allier, there in the soft grits or conglomerates (puddingstone) as at Bastenne and at Pyrimont, again in the limestones of the Jurassic formation to produce the asphalt of Seyssel and of Val-de-Traverse.

Again we are permitted to put side by side the two analyses below to explain the molecular modification which the animal matter experienced on passing into the bituminous state:

	Muscular Tissue.	Boechelbronn Bitumen.
Carbon	62.78	87.00
Hydrogen	6.96	11.20
Oxygen	13.48	1.80
Nitrogen	16.78	....
	100.00***	100.00***

*and **Regnault.
***Boussingault.

Finally, when—by a phenomenon of which some examples are still to be met with in various countries—the bitumen itself is exposed to volcanic actions, subterranean and permanent, at at Baku in Persia, there is given off in this second distillation an oil more or less volatile which—when it is pure and colorless—is named naphtha and which—if it be tainted with oxidized bitumen —is called petroleum.

It has been affirmed that bitumen may be an igneous material pre-existent from the solidification of the terrestrial crust and condensed at the same time with the fusible rocks. We believe that no person to-day recognizes such system, organic traces are evident in the bituminous deposits and moreover, nothing
215 is easier than to reproduce in the laboratory the operation to which is due the creation of bitumen.

Thus we admit that at indeterminate epochs considerable masses of vegetable or animal remains buried beneath sedmentary beds and heated either directly by the central heat or by the invasion of volcanic currents have given birth in an immense distillation to all of the bitumens. It is certain that such gigantic action was exercised in a very various manner; that according to place, temperature, pressure, nature of adjacent rocks, epoch of operation, species of primary materials, the product obtained has been given differences of form, of aspect, composition and properties. But the mode of formation has been the same throughout and the resultant bodies include an identical principle, the bituminous principle, which does not resemble that of any other body whatever and about which it is not permitted to be mistaken.

We leave aside the particular bitumen called "coal" and those which have a special role in industry to occupy ourselves with none other than asphalt and some of the bitumens which intervene in its preparation or in its applications. We thus quit generalities to enter upon our subject.

CONCERNING ASPHALT.

Principal deposits of asphalt. Free bitumen is abundantly distributed over the surface of the globe, it is encountered in almost all volcanic regions and often impregnates the loam grits (Molasses) superposed upon the Jurassic formation. Thus it is found in great quantity and under the most diverse aspects in the
216 environs of Clermont-Ferrand, at times in perfectly free state as in the Fountain of Pitch, at times mixed with fine sands as at Chamaliere and Gerzat, at times disseminated through the

cavities of a spongy marl as at Point-du-Chateau. The most ordinary form of free bitumen is that of a mixture with the quartz sands or green "molasses" of the neo-eocene (niocomienne) as it is obtained at Pyrimont-Seyssel (Ain) and at Bastennes (Laudes —the latter deposit to-day worked out. Free bitumen appears again in Judea in the asphaltic lake at the Caspian Sea floating upon the surface; at the Antilles (Island of Trinidad) imbrued with an earthly base and solid at ordinary temperature.

Bitumen in a state of intimate combination or mixture is more rare; under cover of a species of schist it is encountered still easily enough in the coal basin of Autun (Saone-et-Loire), in that of Buxieres (Allier) in Province, in Dauphine, in the Nord and elsewhere; but in company with limestone there is to be counted in Europe scarcely three or four mines advantageously exploitable.

Bituminous schist is the primary material of an industry, recent and already considerable; from it is extracted by double distillation an oil, light and colorless, which supplies (defrays) the important commerce of mineral illuminating oils. We have no need to occupy ourselves therewith in this note.

Regarding bituminous limestone or "asphalt" properly so called, the most rare of the manifestations of bitumen, this is a rock formed of 90-94 per cent pure carbonate of lime and of 10-6 per cent bitumen. Its aspect is that of plaster stone, its color that of dark chocolate. When cut, the incised surface presents that whiteish appearance which the knife also leaves upon
217 chocolate; the grain is fine, and when the structure is attentively examined it is seen that each molecule of lime is surrounded by an almost atomic coat of bitumen; every grain is thus isolated from its neighbor by a varnish which serves at the same time to glue them energetically to one another. During hot spells this varnish becomes viscid, and often the sole weight of a block suffices to rupture it into two or several fragments; in winter, on the contrary, the bitumen becomes dry and the rock assumes a remarkable durability.

The deposits of asphalt are numbered; nature has shown itself niggard of this precious material, and one will be little able to determine by what law the richest known beds, it may be said the only exploitable, are found almost thrown together into a very contracted zone upon the chart of Europe. It is seen in effect if a right line be drawn north and south from Wissembourg to Chambery that such line has traversed the four mines which to-day supply (defray) the pavement industry: Lobsan, Val-de-Travers, Seysel and Volant, finally Chavaroche. It does not enter

within the limits of this note to develop the conclusions which can be drawn from such a geographical situation as that of the coincidence of said line with the direction of the Jura mountains —that would be to enter upon a discussion too full of hypotheses. No more do we dilate upon the probable mode of impregnation of the bituminous limestones—opinions are divided on this point; some will have it that in the train of the subterranean distillations, concerning which we have spoken above, the vapors were discharged into the atmosphere and forced a passage through vents of the hard rocks to become lodged in the soft; others maintain
that the free bitumens of Judea or other remote countries
218 having appeared were carried upon the surface of the waters
by an universal deluge to impregnate the limestones cold. Grave objections drawn from the very structure of the material can be opposed to both of these systems; the origin of asphalt must then—until new studies have been accomplished—rest in doubt.

Whatever be its formation, the bank of asphalt which appears to be of the same age in the four deposits we have cited, belongs to the upper part of the jurassic formation, and is situated immediately beneath the green "molasses." Besides the mines before indicated, there exist in several regions of France and of Spain outcroppings of bituminous limestone of very inferior richness and of doubtful purity.

20. Extraction, Pulverization, Sifting. Asphalt is obtained after the manner of masonry stone (moellon) with powder and tamping-iron; often the rock is sufficiently soft for one to make blasting holes with the auger. Extraction proceeds, either in open quarries, as at Pyrimont-Seyssel and Val-de-Traverse or under galleries as at Volant and Chavaroche. The asphalt rubble is piled upon the floor of the mine, in lots of 100 cubic meters; a part is forwarded to the public works in the state of rock, the rest is sent to factories for the fabrication of mastic. There is need, ordinarily, to avoid great production during summer, since heat causes the rock to depreciate which tumbles, of itself, into powder. This inconvenience ceases if the supplies be stored in the galleries. Summer is also the season most dreaded by miners who work in quarries; under the action of the sun the bank of asphalt softens to the point that the blows of the drill are without effect and the
workman is obliged to content himself with the pick, the
219 crowbar and the wedge. The cost of hand labor doubles
oftentimes from winter to summer.

Rock destined for the making of mastic is crushed, then pulverized.

Crushing: Crushing of the rock is a simple labor, out it does not fail to assume a certain importance in the ensemble of operations as the sequel of a special circumstance we have already signalized above. We have stated that asphalt—very hard in winter—softens considerably during hot spells; it results thence that crushing—easy in the cold season—becomes very laborious in summer, impossible indeed oftentimes, when the blocks to cut up have been exposed to a burning sun. Under the action of the sun, the bitumen of impregnation liquefies, the material grows slack and the crusher strikes against nothing more than a species of paste which flattens without breaking. Therefore, the operator avoids having this labor to do in summer, at least that it be not carried out in the very galleries where the rock is extracted (mined). It is admitted that on average, the hand labor for crushing bituminous limestone varies from winter to summer in the proportion of 3 to 5.

Ordinarily, the rock is broken to the size of the pebbles that serve for the stoning of roads; it is shaped up for measurement; a pile of block rock transformed into crushed rock loses—it is found—about 20 per cent of its volume.

The crushed bituminous limestone is thereafter pulverized, then sifted.

Pulverization can be effected in two ways: Hot, by decrepitation; cold by grinding.

220 Hot Pulverization. The crushed rock is placed in open cases of light sheet-iron, 1.00 meter, by 0.6m., by 0.2m. Said cases are introduced into flat cast-iron retorts analogous to the horizontal retorts employed in the distillation of bituminous achists; under these devices a mild, uniform heat is maintained. The following phenomenon is produced: The bitumen with which the rock is impregnated—solid at ordinary temperature—softens and flows; the calcarious molecules separate from one another and tumble into powder. From time to time the cases are shaken to present successively all parts of the asphalt to the action of the heat; the material thus treated (shocked) is then thrown upon a flat place when it is stamped in order to accomplish the pulverization; finally it is passed through sieves which retain certain of the more rebellious parts named (grabons) ("gravel"); these "grabons" are crushed apart by blows of the mallet and restored to the sieves. The powder obtained is ready to be transformed into mastic.

Decrepitation is also produced in special apparatus of which we will speak apropos the streets of compressed asphalt rock.

Pulverization by decrepitation such as we have just spoken of in the first system which was employed; it presents the great advantage of requiring no motor whatever but it pays for this advantage by numerous inconveniences. Were it possible to submit all parts of the material to an uniform temperature and which was maintained constantly between the melt-point of the bitumen of impregnation and that of its vaporization, no other system—assuredly—could be preferable; but this condition which obtains—it may be—in a laboratory with sustained attention is almost impossible to realize in practice. Whatever care is there brought
221 to bear the temperature of volatilization is always exceeded and thus is lost a certain quantity of bitumen which needs to be later restored—artificially; on the other hand, as all the material cannot be heated equally, decrepitation of the interior parts is not attained other than by burning those which touch against the hot surfaces.

Pulverization by decrepitation is therefore, under the actual state of its practice an essentially defective operation. Recourse thereto should not be had unless the operator cannot do otherwise, that is to say at times when he has not sufficient motive force at his disposal. Nevertheless, it cannot be denied that the idea of reducing the lime to powder by the simple softening of its oils of impregnation is a seductive idea and one should not be surprised to see that—even to this very time—it has not been completely abandoned. We will return to it certainly, the day when the operator shall have succeeded in heating the rock uniformily and methodically in such fashion that the temperature rests always below the point where the bitumen assumes the state of vapor. That is an apparatus to contrive.*

However, the powder employed in establishing compressed asphalt streets is obtainable up to the present by decrepitation. We will take up this question again in its place.

Cold Pulverization. At the works where asphalt mastic is prepared in gross, the rock is pulverized cold. Two species of apparatus are employed: The crusher; the cone-mill. The

*Only a few months since a means has been employed that appears to be a solution of the problem and which consists in introducing a jet of vapor into a cylinder where the rock is enclosed; under such action the rock tumbles into powder at the end of 10 minutes. The applications of this system are under study.

222 first system is none other than the vertical burr of stone or cast-iron furnished with scraper and the other accessories which are everywhere seen. The second resembles sufficiently well the ordinary coffee mill in large dimensions; it has a cast-iron cone 0.6 to 0.7m., at base and 0.8m., height mounted upon a vertical arbor and moving within a shell of the same metal; the cone and the shell are furnished with teeth which break the stone and reduce it to dust.

On leaving the mill, the powder falls into cylindrical bolters of about 0.02m., mesh; the sifted powder is ready to be delivered for trying (cooking), the grabons (gravel) are returned to the mills.

3d. Cooking: To make asphalt mastic such as is employed in public works, the rock is subjected to a cooking under the conditions following.

The operator provides cast-iron semi-cylindric boilers, some two meters long and about one meter diameter placed horizontally above return-flame furnaces. A shaft fixed at the axis of the cylinder and carrier of radial guide blades agitates the paste and successively puts all parts thereof into contact with the hot surface; each apparatus is surmounted by a shut-metal cover, also semi-cylindric, which is raised from time to time to introduce the material and watch the march of the operation; finally, exit pipes are attached to the flanges of the boilers to vent the watery vapors which escape abundantly at the commencement of the cooking.

At the beginning there is thrown into each boiler 90 to 100 kilogr., of free bitumen which soon enters into fusion; when it has almost attained its temperature of volatilization, the agitator is put in motion and shovel-full by shovel-full the asphalt pow-
223 der is thrown in; on falling into the hot liquid, the powder deprecitates and mixes with it intimately; the introduction is continued till the moment when the mixture ceases to be pasty and becomes friable which the operator recognizes as that when the material commences to attach to the bottom of the heater and to the blades of the agitator. At such instant, the apparatus has received about 100 kg., of free bitumen and 1,400 kg., of asphalt powder. After being heated and agitated during six hours the operator proceeds with the casting.

Mastic is cast in built-up cylindric moulds each of sheet-metal bent in semi-circle in fashion to form loaves of 0.3 meters diameter from 0.10 to 0.12 meters height and weighing about 25 kg. A trade mark incrusted in one of the metal plates, imprints its relief upon each loaf to attest its authenticity; these are the loaves

which—sent about (i. e., scattered over) public ways—are re-cast in movable cauldrons for making side-walks or other asphalt structures.

What passes during this period of cooking? What modifications are wrought upon the elements of asphalt? In sequel of what metamorphosis does the bituminous rock become a powerful mastic easily fusible and so different from its primary material? It is indeed difficult to understand. The free bitumen added is absorbed evidently by that already lodged in the pores of the limestone; carried there it penetrates even into the most intimate cavities of the asphalt as a drop of oil follows the path traced by another drop: but it will not be pretended that the free bitumen carries with it any new properties; its functions are purely accessory; it aids in the fusion of the rock; it supplies the impregnating oils lost by evaporation; it prepares the paste for trituration and cooking as the saliva—if we may be permitted the comparison—moistens the food, disposing it for mastication and favoring its transformation.

224

Whatever may be the action of the added bitumen, it is a constant fact that the more said bitumen has geologic analogy to that with which the rock is impregnated, the better is the mastic obtained. We shall speak elsewhere as to what can be the influence of this more or less resemblance upon the duration of asphalt constructions.

Mastic prepared from rock abundantly and equally impregnated, fine of grain, added to a bitumen nearly its congener, is a black body of reddish luster, elastic, infusible by the most burning sun and endowed with a bituminous odor almost agreeable. We shall return again to its special properties when we speak of its applications.

4th. *Extraction and preparation of the bitumens which enter into the production of mastic.* We have just seen that free bitumen plays an important role in the fabrication of asphalt mastic; it fulfills another no less grave at the time of its application. Before going too far we cannot exempt ourselves from entering upon certain details of this subject.

Thus—as we have said before—bitumen occurs either in absolutely free state or else, and more generally, agglutinating quartz sands or, finally, mixed with marly or earthy materials.

In the first case, of which the Fountain of Pitch is an example, one is obliged to recover the bitumen at its exit from the ground, to purge it by simple refining from all the impurities with which

it may be soiled, and obtains thus a viscid body of fine brilliant black, in a word—pure bitumen.

225 In the second case, the operator exploits—as at Pyrimont-Seyssel at Bastennes or at Claremont—the very irregular banks of "molasse" (fine sandy loam) saturated with bitumen; the blocks extracted are crushed into pieces of 0.07 to 0.08m., on side, thrown into cauldrons full of boiling water and stirred for about an hour. Bitumen brought to 100° liquefies, the "molasse" falls into sand and the bubbling of the water, acting mechanically, each grain strips itself of its bituminous envelope, which proceeds to float; the surface is skimmed to recover the bitumen and the sand rests clean at the bottom; the sand is removed, the boiler recharged and the operation recommences.

When the "molasse" is of large grain, as found at Lussat (Auvergne) the sand is completely precipitated and the bitumen is almost pure; but it is very rare that the molasse is not of very fine grain and then the material taken off by the skimmer contains always a large quantity of disaggregated grit drawn in by the ebullition and disseminated through the bitumen. To purge the skimmings of this sand they are set boiling, the water evaporates, the sand gains the bottom by virtue of its density and the workman decants. Bitumen obtained by this second operation is absolutely pure but the sand left at the bottom of the boiler yet keeps a volume almost equal thereto and which it is impossible to recover practically. This system of extraction, costly and barbarous, has been described by d'Alembert* like as it is still employed today. It has not taken a pace in one hundred years. However, novel processes are under study. Although they have not given thus far the hoped-for results it can be foreseen that it will soon be possible to suppress the methods so in arrears of the progress of the industry.

226 In the third case that where the bitumen is mixed with earthy matters, the operator is obliged to have recourse to other means; the bitumens of Trinidad for example, occur in immense dry lakes the bottom of which is entirely composed of a sort of blackish rock which is none other than bitumen solidified by the presence of foreign matters and by the evaporation of a certain quantity of essential oils. The rock is taken out, shipped to France where it is subjected to the treatment following: A part of the solidified bitumen is distilled and there is obtained

*Encyclopedia—Article: "Asphalt."

from the worm a bituminous oil analogous to the heavy oils from schist; such oil serves to dissolve in special cauldrons three other parts of solid bitumen. The dissolution is effected hot; the most dense earthy gangues go to the bottom and by a decantation the pure bitumen is separated therefrom and is barrelled and sent off into the industries.

In general, all bituminous materials—calcarious, schist, sand, solid rock of Trinidad—yield on distillation the same product, an oxygenated multo-hydrocarbon, the "petroleum" of the ancients; sometimes the aroma varies, the bitumen of Clermont for example, exhales a strong garlicy odor which is to be found nowhere else; but among all the aspect, the composition, the combustion are sensibly identical. Consequently, the operator has in certain cases and when economy was found in doing it been led to substitute different oils for each other. Thus, in the operation which consists in dissolving the crude Trinidad bitumen in its proper oil of distillation, it has been possible to replace said oil by that which is obtained on distillation bituminous schists.

The principal species of bitumen which serve either in the fabrication or else in the application of asphalt mastic are those
227 which we have just enumerated; we repeat them: Native bitumen (Clermont); bitumen coming from the leaching (trying) of "molasse" (Pyrimont-Seyssel, Bastennes, Boechelbronn, etc.); Purified Trinidad bitumen. Besides these three species there are employed further: the bitumen drived from the purification of heavy schist oils; the bitumen residue from the distillation of coal; the mixed bitumens called grease bitumens.

The schist bitumens are utilized without disadvantage when they are not too concentrated; their composition is almost the same as that of natural bitumens and were it not very difficult to obtain them always alike we would allow little difference between their usage and that of the best native bitumens.

As to the bitumens or tars of coal and of fats the presence thereof ought to be proscribed as far as possible in asphalt construction of slight thickness. Coal bitumen, also called "gas tar," renders mastic brittle in winter and soft in summer, it exhales on application an insupportable odor; finally, its essential oils being very volatile evaporate promptly on contact with air; pavements into the composition of which it enters become friable and wear out quickly when they have a frequent circulation to support. The bitumen of tallow (fat bitumen) far more perhaps than that of coal is to be dreaded in public works. The greasy elements which

it contains far from uniting with the bitumen of impregnation of the asphalt, dissolve it on the contrary and form thereof a malleable paste which wears rapidly away under the feet of the passers-by. Both of these bitumens are incapable of constituting good side-walks, and if their low price still causes them to be admitted by some contractors they should be severely interdicted by architects and engineers.

228 5th. Application of Asphalt. The applications of asphalt are unlimited; our design is neither to describe all those which have been discovered nor to indicate those which remain to be discovered. These should be the matter of a special treatise; we limit ourselves to signalizing the principal uses man makes of it either in highways or in hydraulic constructions and we follow, as the more logical, the order here set forth, viz: I. Application of raw asphalt. II. Application of asphalt mastic.

I. *Application of raw asphalt. Compressed asphalt roadways.* From the origin of asphalt it had been possible to recognize therein the following property: The carts which transported the rock from the mine to the places for treatment* would often let fall upon the road some fragments which the wheels crushed, when the route was covered with this debris, summer supervened, the heat softened the bitumen of impregnation, the wagons which followed on compressed the material and there was formed a crust —solid, dense, elastic, easy to the feet of the horses and of almost no wear. We have seen in nearly all asphalt mines, similar roadways and one of these can be remarked at Pyrimont-Seyssel, of which the vestiges—still robust despite the barbarous system of braking in vigor in the country—are to-day nearly sixteen years old.

It was not until about 1850 that this lesson of chance was voluntarily put to profit. A Swiss engineer, Mr. Merian, built at this period in the little village of Travers (Canton of Neufchatel) a roadway from heated and compressed asphalt rock. According to the experience of Mr. Merian the asphalt was simply spread

229 out upon the macadamized road and subjected to the roller; despite the instability of the site and the irregularity of repair the route at Travers is still in sufficiently good state.

The same year Mr. Darcy, inspector-general for bridges and highways, on return from a special mission to London, published

* Before it was thought to apply asphalt for building sidewalks and streets it was distilled to obtain an illuminating oil analogous to schist oil.

in the "Annals" a long and learned memoir wherein after having set forth and discussed all the systems used in London and Paris, declared that the solution of the problem was "in the employment of asphaltic rock laid cold." Experiments made at Paris in this view (sense) did not—however—yield other than incomplete results; they were renounced. An engineer so competent as Mr. Darcy was in highways matters should not have deceived himself at this point; besides, he had been cognizant later on that his sole error was in having prescribed the use of the asphalt, cold. Rock asphalt heated, pulverized by decrepitation, laid down over the body of the street, stamped and compressed by rollers, resumes on cooling the state in which it is found in its deposits; this it is which produces its strength, its elasticity, its homogeniety, its *solidarity*. Evidently, it is not possible to reach the same end with asphaltic rock laid cold.

About the same period another distinguished engineer of the Bridge and Highway Corps, Mr. de Coulaine, made some analogous attempts upon the Samur bridge and the roads of the depatment of Maine-et-Loire of which he also rendered an account in the "Annals."

At length—it is now nearly six years ago—the street of compressed asphalt obtained its entry into the compulsory theater for all serious trial. It penetrated into Paris. Rue Bergere was its first step taken, along the Conservatory of Music, after which the result was awaited for four years. The result was such that 230 toward the close of 1858 Palais-Royal place, the point most worn of all Paris, was designated by the administration to be macadamized in asphalt; since that moment numbers of streets have changed their pavements over to the new system and nothing gives cause to suppose that this success need be lessened. It is to Mr. Homberg, engineer-in-chief, and Messrs. Vaudrey and Veyssieres, general engineers of the Paris municipal service, that this splendid art and its remarkable applications are due.

This is how one proceeds in the installation of compressed asphalt streets: The asphaltic rock extracted from its deposits and broken to the size of pebbles which serve for the metal of macadamized route is decrepitated as we have before indicated* but in special apparatus which consists of large sheet-metal cases sustained upon iron legs, and beneath which is placed a furnace; these apparatus are transported to the working spot or to a place near by in order that the decrepitated powder shall lose the least heat

*At the Article on Pulverization, p. 78.

possible. The body of the street has preliminarily been covered over with a bed of beton, the thickness of which is ordinarily 0.1 metre, but varies with the solidity of the soil. Upon certain plots, as good macadamized and well repaired routes, it may be possible to suppress the beton entirely; upon others, where the earth is badly settled, the operator is obliged to carry it to 0.15 metres. Upon this beton, well rammed, cleared and shaped according to the exact slope,** is spread the decrepitated material that is tamped, and of which a bed is made from 0.04 or 0.05 m., according to the circulation which it needs to support.

The compression is next regulated by moving over the 231 surface a roller of 2,500 to 3,000 kilogr. weight; two hours later the street can be opened to vehicles.

The asphalt street thus constructed permits a united surface easy to the roll of vehicles, facile to the draft of animals, absorbing completely then oise of the wheels; it produces neither mud nor dust, because the asphalt wears only imperceptibly,* and if these are seen sometimes upon the established streets in Paris it is because such streets being almost all of slight length, dust and mud overflow there from the neighboring pavements the abolition of these two pests (dust especially so formidable in the show places of the shops) alone assure to it the success of the system. The impereability of the bituminous bed is also a precious property; it protects the subjacent ground and suppresses one cause of insalubrity which block-pavement carries always with it; the joints of the pavement store without cessation organic materials which the ...rius of habitations and slop-waters furnish them; such materials ferment, putrify and the action of the sun thereon spreads miasmas into the atmosphere to the great damage of the public hygiene. To these advantages can be added: The rapid melting of snows, simplicity of maintenance and complete absence of shaking in bordering structures.

** The convexity of the street should be extremely slight; it need not pass beyond that which is strictly necessary for the drainage of water; with compressed asphalt streets it is an inconvenience that cannot be avoided, but which should be reduced as much as possible; it is to this that the sole accidents are due which are there produced. In Lyons, where the convexity of the compressed asphalt street had been made the same as of the paved streets, some cavalry horses fell down, and the military authorities, without taking into account the causes of accident nor the opinion of engineers, has compelled the demolition of the work. In Marseilles—on the contrary—where the asphalt street was laid almost flat, not a single accident has happened, and yet all the circulation between the city and the Port of Jolyette—the most enormous circulation possible—passes over it.

* It has been calculated that the medium wear is about one millimeter per annum.

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232 Certain it is that streets of compressed asphalt are the streets of luxury, and that cities of a certain importance can alone permit them; but the advantages thereof are so numerous and so incontestibly established today that all frequented streets of the provincial cities are designated beforehand to receive an application thereof. Besides, the question of price is less difficult to attack in that it does not appear at first view because the asphalt street on primary establishment costs one-third less than block pavements, and maintenance almost three-quarters less than the macadam of the Paris boulevards.* (Page 90.)

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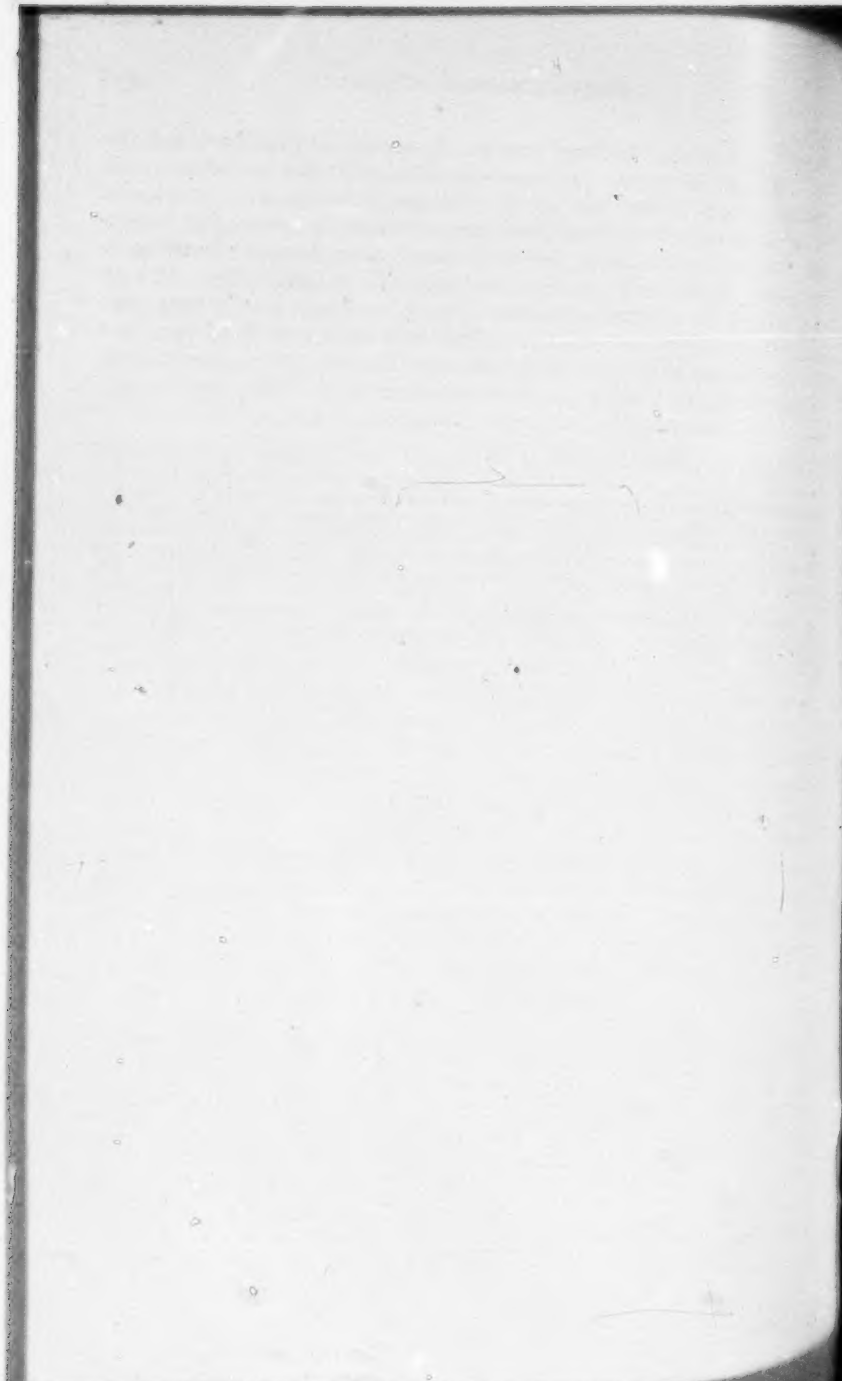
*Since this article was written an incident has happened which we cannot pass by in silence. Towards the middle of last winter the pavement of the rue Neuve-des-Petite-Champs was entirely reconstructed in compressed asphalt; at the close of a few days numerous fissures and sunken spots became manifest from one end of the street to the other. These accidents, which had not been before reported elsewhere, surprised the engineers, who sought to discover the cause. The street way was demolished, and it was recognized that the asphalt had been laid upon a beton so humid that the water vaporized by the heat of the powder had penetrated the asphaltic bed and completely ruptured its tenacity. The street has been reconstructed in entirety, and since then comports itself perfectly. (L. M., April, 1861.)



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NOTE

SUR LES CHAUSSÉES EN ASPHALTE COMPRIMÉ.

PAR M. LÉON MALO.

L'établissement et l'entretien des chaussées de Paris sont devenus depuis quelques années un grave sujet de préoccupation pour l'administration municipale; l'accroissement de la circulation en général, et en particulier celui du nombre des voitures, suit une progression tellement rapide et si difficile à formuler par une loi, que nul ne peut prévoir où il s'arrêtera; aussi le service de la voirie parisienne ne paraît-il pas sans inquiétude sur l'avenir. M. le préfet de la Seine lui-même, dans le rapport présenté en 1861 au conseil municipal, exprimait en ces termes son sentiment : « Le pavé de Paris est de plus en plus difficile à maintenir en « bon état, les grès de bonne qualité deviennent rares, les plus durs ne « sont pas assez tenaces d'ailleurs pour bien résister à la fatigue d'une « circulation qui a doublé depuis quelques années, car le nombre des « voitures circulant dans Paris, qui était de 21,690 en 1853 montait, déjà « à 38,763 en 1859. » Quant au macadam « qui s'est emparé de toutes les « grandes artères de Paris et qui s'étend à mesure qu'elles se dévelop- « pent à travers la ville, il est une cause de dépenses inquiétante par la « progression ascendante qu'elles suivent sous la double action de l'ac- « croissement des surfaces à entretenir et de la circulation qui les sil- « lonne, et en même temps un véritable fléau pour les piétons, ce qui « n'est pas un détail de peu d'importance dans un pays démocratique « comme le nôtre. »

Je ne veux pas faire leur procès au macadam et au pavé, ni renchérir sur les anxiétés de M. le préfet de la Seine; cependant je ne puis me dispenser de compléter par quelques détails techniques les explications renfermées dans l'extrait qu'on vient d'entendre, afin de montrer à quel point les matériaux employés à la voirie sont insuffisants et combien il est nécessaire de recourir à de nouveaux expédients.

L'antique pavé de grès, qui depuis Louis XI supportait tout le poids de la circulation parisienne, se trouve dépaysé au milieu du prodigieux mouvement qui douze ou quinze heures par jour envahit maintenant la moitié des rues de la capitale. Sous cette irrésistible action les blocs se disloquent, les angles et les arêtes s'émoussent, la surface se déforme et

se bosselle; les joints absorbent les matières organiques répandues sur le sol, délayées par le brouillard ou la pluie, et les restituent à l'atmosphère sous forme de miasmes au premier rayon de soleil; ainsi, cahots, tapage, humidité malsaine ou sécheresse délétère, tels sont aujourd'hui dans les rues fréquentées les effets du pavé de grès.

Pour éviter ces défauts rendus de jour en jour plus insupportables par le développement du roulage, on a essayé de substituer au grès des roches plus dures, notamment le porphyre belge. On aurait certainement obtenu ainsi des résultats très-satisfaisants, si d'autres inconvénients provenant de l'excès même de ses qualités n'avaient rendu ce nouveau pavage dangereux à fréquenter. En effet, on avait d'abord, pour éviter les cahots et la boue, taillé et ajusté les blocs avec un tel soin, que le joint était presque supprimé; après une circulation de quelques mois, la surface se polissait et rendait le glissement des chevaux imminent. Cet essai, dont on peut voir un échantillon rue Taitbout, n'a pas pris de développement sérieux.

On eut alors recours à un tempérament qui en atténuant ce grave défaut en fit renaître un autre, un des plus fâcheux de l'ancien pavé; on espaça les blocs de porphyre en donnant aux joints une largeur de deux à trois centimètres, on retomba ainsi dans les cahots et dans la boue. On a cependant à peu près remédié au mal dans la rue Drouot en remplissant les joints d'un mortier de chaux hydraulique; le pavé ainsi consolidé présente une surface dure et sonore, mais homogène et résistante.

Telle est la limite de perfection atteinte jusqu'à ce jour par le pavé, et cependant on sait quelle autorité et quelle compétence, en matière de voirie, possèdent les ingénieurs du service municipal de Paris; s'ils ne sont pas parvenus à mieux faire, c'est probablement que le pavé a dit son dernier mot, et il est à craindre qu'il ne soit désormais, du moins dans les rues très-passagères, au-dessous de sa tâche.

Quant au macadam, j'aurais trop beau jeu, en cette saison surtout, à le combattre. Le macadam n'a été et ne sera jamais dans les grandes villes qu'un système de transition: introduit à Paris, sous le couvert d'une nécessité stratégique, il n'a subsisté jusqu'ici, (et Dieu sait au milieu de quelles imprécations!) que parce qu'on n'a rien trouvé pour mettre à sa place, et que dans certaines voies, d'où le pavé était proscrit, il fallait bien marcher sur quelque chose; on m'accordera facilement, sans que j'aie besoin de répéter ce qu'on a dit cent fois de la boue proverbiale du macadam, de sa poussière si funeste aux voitures, aux magasins et aux appartements riverains, que ce système était condamné avant d'être adopté et que si son provisoire a déjà quinze ans de durée, c'est que chez nous rien n'approche du définitif comme le provisoire.

On a tenté et l'on tente encore tous les jours d'incalculables efforts pour approprier le macadam; on a perfectionné son arrosage en été et

son balayage en hiver; on a substitué à grands frais le caillou de granit au caillou calcaire; on a multiplié les cantonniers; chaque matin les désordres de la veille sont réparés avec une rapidité et un soin incroyables; mais dès que le torrent de la circulation s'est de nouveau emparé du sol, le fléau reprend ses droits, et pendant au moins trois cents jours de l'année, la chaussée redevient un océan de boue ou un amas de poussière infecte. Le macadam est imperfectible, la science des plus habiles ingénieurs s'est vainement épuisée à prouver le contraire.

Tel est l'état actuel de notre voirie; son bilan n'a, comme on voit, rien de très-rassurant, et c'est à l'instant même où la ville de Paris, tout entière aux soins de ses embellissements, aurait le plus besoin que nulle tache ne fît contraste avec sa nouvelle et magnifique transformation, que cette impuissance se révèle avec le plus d'opiniâtreté.

Devant une semblable situation, les chercheurs n'ont pas fait défaut; cent systèmes ont été proposés: on a imaginé des pavages de toutes formes, de toutes substances; on en a fait en bois, en fonte, en caoutchouc, que sais-je? Beaucoup de ces systèmes sont mort-nés; d'autres à peine viables ont cependant, comme le pavage en bois, assez vécu pour fixer l'attention du public et se préparer une chute plus bruyante. Un seul de tous est resté debout, et après dix années d'un rude et laborieux noviciat est parvenu à se poser comme le rival sérieux du pavé et du macadam, c'est l'*asphalte comprimé*.

Je crois le moment venu d'entretenir la Société de ce remarquable perfectionnement. Ce n'est pas un essai dont je vais parler, c'est un procédé pratique adopté par l'administration municipale et qui a fait largement ses preuves, puisque la surface des chaussées en asphalte comprimé établies dans Paris dépasse, à l'heure qu'il est, *cent mille* mètres carrés.

Les principes qui dirigent l'application de l'asphalte aux chaussées diffèrent si essentiellement de ceux qui régissent son emploi dans la construction des trottoirs, qu'avant d'aller plus loin il me paraît utile d'entrer dans quelques détails sur l'origine de la matière première, sur sa préparation et sa pose.

L'asphalte est un carbonate de chaux parfaitement pur, imprégné naturellement, d'une manière très-intime, d'une petite quantité de bitume qui varie entre 6 et 10 p. 100. Cette roche s'exploite par bancs réguliers de 4 à 7 mètres de puissance à Scyssel, département de l'Ain; au Val-de-Travers, dans le canton de Neufchâtel en Suisse, et sur plusieurs autres points de la même région jurassique.

Si l'on porte l'asphalte à une température voisine de 100°, le bitume d'imprégnation qui forme le liant des molécules se ramollit, les grains se séparent et la roche tombe en poussière; si pendant que cette poussière est encore chaude on la comprime dans un moule, les molécules se recollent les unes aux autres et la matière reprend par le refroidissement,

mais sous la nouvelle forme qu'on lui a donnée, l'aspect, la dureté et en général toutes les propriétés que la roche possédait au sortir de son gisement.

Toute la théorie des chaussées en asphalte est là.

Supposons qu'au lieu d'enfermer la poudre chaude dans un moule, on l'étende sur un sol résistant, en donnant à la couche une épaisseur de quatre ou cinq centimètres, et que, soit au pilon, soit au rouleau, on comprime cette couche, on obtiendra, lorsqu'elle sera refroidie, une croûte monolithe absolument semblable à la roche primitive.

Voici comment est conduite l'opération dans les travaux actuellement en cours à Paris.

La roche expédiée de la mine est transportée dans des ateliers spéciaux où elle est mécaniquement broyée et réduite en poudre, puis passée dans des réchauffeurs où sa température est élevée à 140° environ; dans cet état elle est conduite au lieu d'emploi; malgré les distances considérables qu'elle parcourt souvent pour se rendre à pied d'œuvre, la poudre enfermée dans des caisses *ad hoc* perd à peine dix ou quinze degrés de chaleur pendant le trajet.

La forme de la chaussée à asphalter a été préalablement recouverte d'une couche de béton de dix centimètres d'épaisseur; sur cette couche bien desséchée (nous verrons plus loin combien ce dessèchement est nécessaire) on étend la poudre d'asphalte chaude, on la pilonne au moyen de dames en fonte, puis on la comprime successivement avec trois rouleaux, le premier de 200 kilogr., le second de 800 kilogr. et le troisième de 1,800 kilogr., jusqu'à ce qu'elle soit réduite à une épaisseur uniforme qui, pour la ville de Paris, a été fixée à cinq centimètres.

Deux ou trois heures après le passage du dernier rouleau la chaussée est assez refroidie et par suite assez résistante pour être livrée à la circulation.

Rien n'est plus simple, comme on voit, que l'application de ce système, si ce n'est peut-être l'historique de sa découverte. L'invention du procédé qui paraît destiné à régénérer la voirie de Paris est due au hasard : les charrettes qui transportaient l'asphalte des mines aux usines où se prépare le mastic destiné à la confection des trottoirs, laissaient souvent tomber sur les chemins des fragments que les roues écrasaient; lorsque la route était couverte de ces débris et que le soleil survenait, la décrépitation se produisait spontanément et les voitures comprimant petit à petit la poudre accumulée finissaient par former une croûte solide qui n'était autre chose qu'une chaussée naturelle en asphalte comprimé.

Ce fut un ingénieur suisse, M. Mérian, qui, le premier en 1849, mit à profit cette leçon du hasard et construisit, sur la route cantonale qui traverse la petite ville de Travers, une chaussée en asphalte.

Malgré l'instabilité de son assiette et l'irrégularité de son entretien, cette chaussée est encore en parfait état.

En 1850, M. Darcy, inspecteur général des ponts et chaussées, après avoir visité les systèmes en usage à Londres et dont la variété, comme on sait, est infinie, déclarait dans un rapport adressé au ministre des travaux publics [1], « que la solution de la question si importante et si con-« troversée de la viabilité dans les villes se trouve dans l'emploi judi-« cieux de la roche asphaltique, » il allait même jusqu'à en proposer l'application immédiate sur une partie des boulevards.

Ce ne fut cependant qu'en 1854, que la première chaussée en asphalte comprimé fut par les soins de MM. Homberg, ingénieur en chef, et Vaudrey, ingénieur ordinaire du service municipal, établie à Paris rue Bergère, sur les débris d'un essai où le bitume avait joué un rôle, mais qui n'avait vécu que quelques mois. Depuis ce moment la chaussée de la rue Bergère, sauf la portion située en face de la rue du Conservatoire et qui est en asphalte coulé comme les trottoirs, n'a jamais été réparée.

A partir de 1854, le système des chaussées en asphalte s'est développé suivant une progression rapide.

En 1854, les premiers essais occupaient une surface de 7 à 800 mètres, quatre ans plus tard cette surface s'élevait à 8,000 mètres, aujourd'hui, comme je l'ai dit tout à l'heure, elle est supérieure à cent mille mètres carrés.

Les chaussées publiques ne sont pas d'ailleurs le seul débouché de l'asphalte comprimé; les cours de l'hôtel du Louvre, du Grand-Hôtel, des gares de l'Ouest et du Nord, et d'un grand nombre de maisons particulières ont reçu des applications dont le nombre tend chaque jour à s'accroître, moins peut-être à cause de la solidité de la surface qu'à cause de son insonorité qui, dans ce cas spécial, est son avantage le plus recherché.

Il ne faut pas croire cependant que le système qui fait l'objet de cette communication ait été préservé des écoles et des mécomptes inséparables de toute innovation qui cherche sa voie; les épreuves n'ont pas manqué. Sans parler des difficultés nombreuses qu'il a fallu traverser pour arriver à une bonne préparation de la matière, difficultés à peine vaincues en ce moment, le nouveau procédé s'est trouvé en face de la défiance, ou tout au moins de la timidité que rencontre toute idée nouvelle chez les mieux disposés et les plus compétents. Un incident que je ne puis passer sous silence, car il a eu tout le monde pour témoin, est venu même porter aux chaussées en asphalte un coup dont elles ne se seraient pas relevées, si elles n'avaient su trouver dans un échec apparent les éléments d'un nouveau succès. Je veux parler de la réfection de la rue Neuve-des-Petits-Champs.

1. *Annales des ponts et chaussées*, 2e série, 1850.

L'administration municipale avait résolu, en 1859, de substituer l'asphalte au pavé de la rue Neuve-des-Petits-Champs; la saison était avancée et pluvieuse, c'est-à-dire aussi défavorable que possible, on se mit néanmoins à l'œuvre. Le travail fut des plus pénibles; on ne parvint jamais à sécher le béton, et l'on fut obligé, dans l'impossibilité où l'on se trouvait, d'obstruer longtemps une rue aussi fréquentée, de poser la poudre sur des surfaces humides. Au bout de quelques jours des affaissements se manifestèrent sur toute la longueur de la rue, la croûte asphaltique se dégrada, on fut obligé de l'enlever; on s'aperçut alors que la poudre chaude posée et comprimée sur du béton mouillé avait vaporisé l'eau qui, cherchant à s'échapper, avait pénétré l'asphalte, l'avait désagrégé et réduit en une poussière que la circulation des voitures n'avait pas eu de peine à disperser; on découvrit, en outre, que la couche de béton sous-jacente avait été établie sur le remblai glaiseux d'un égout fraîchement construit. Ce remblai non pilonné n'avait pas tardé à tasser en disloquant le béton et par conséquent l'asphalte qui n'ayant aucune résistance propre avait cédé partout où le béton avait cédé lui-même. La chaussée de la rue des Petits-Champs, reconstruite dans de meilleures conditions, s'est parfaitement comportée depuis.

Construite comme je l'ai indiqué plus haut et avec les précautions que l'expérience a enseignées, la chaussée en asphalte comprimé jouit des propriétés suivantes :

Elle ne produit ni boue ni poussière.

Elle est parfaitement insonore.

Elle diminue d'une manière très-notable le tirage des chevaux.

Elle réduit les frais d'entretien des voitures dans une proportion qu'il est difficile de fixer dès ce moment, mais qui, lorsque des quartiers tout entiers seront asphaltés, ne peut manquer d'être considérable.

Enfin, l'absence de chocs et de cahots influe très-certainement, et c'est du reste l'opinion de M. Darcy, sur la durée et la stabilité des constructions riveraines.

J'ai dit que les chaussées en asphalte ne produisaient ni poussière, ni par conséquent de boue; en effet, elles ne s'usent pas d'une manière appréciable, elles diminuent d'épaisseur, il est vrai, pendant la première année de service, mais uniquement parce que la circulation des voitures, achevant le travail commencé par les pilons et le rouleau, continue à comprimer la croûte asphaltique jusqu'à ce qu'elle ait pris la dureté et la densité du calcaire le plus compacte. Après ce premier effet passé, l'usure annuelle est à peine d'un millimètre; la matière asphaltique ne donne donc naissance ni à la poussière, ni à la boue; elle reçoit seulement celles apportées des chaussées environnantes ou produites par le fumier des chevaux et les ordures rejetées des maisons voisines; un lavage journalier suffit pour l'en débarrasser.

Les chaussées en asphalte sont insonores : je n'ai pas besoin d'insister sur un pareil avantage, dont la valeur s'apprécie, surtout aux environs des grandes administrations, des bibliothèques, de tous les établissements où le silence est nécessaire. Aussi est-ce précisément devant les ministères de la rive gauche, devant l'hôtel du Crédit foncier, devant le Palais-Royal et la bibliothèque Impériale, que les premières applications ont été faites. Des pétitions sont à chaque instant adressées à M. le préfet de la Seine, par les habitants des rues bruyantes, pour obtenir que l'asphalte y remplace le pavé. Quelques personnes reprochent à l'asphalte, comme un grave défaut, cette insonorité qui semble cependant être une de ses plus précieuses qualités : « On n'entendra pas, dit-on, venir les « voitures, et l'on sera sans cesse exposé à se faire écraser. » Je ne crois pas que, dans l'espèce, l'absence de bruit puisse être plus dangereuse que le bruit lui-même; on risque au moins autant de se faire écraser quand on entend vingt voitures que lorsqu'on n'en entend aucune. Je ne sache pas qu'on ait eu depuis dix ans un seul accident semblable à déplorer; on cherchera d'ailleurs et l'on trouvera facilement le moyen d'avertir les piétons, ne fût-ce qu'en attachant des grelots aux chevaux. Les cochers de Paris ont trop l'intelligence de leurs intérêts pour ne pas s'arranger de façon à n'écraser personne.

Le tirage des chevaux est sensiblement moindre sur l'asphalte que sur le pavé ou sur le macadam fraîchement rechargé; il est facile de s'en convaincre en examinant les différences d'efforts musculaires exercés par les chevaux attelés, lorsqu'ils passent de l'une à l'autre chaussée; on peut faire la même observation sur les hommes conduisant des voitures à bras.

Il semble de prime abord évident que l'entretien des voitures doit se ressentir d'une manière très-notable de la suppression des cahots. M. Darcy, dans le mémoire que j'ai cité plus haut (pages 262 et 263), estime que les frais d'entretien et de renouvellement des chevaux et des voitures diminueraient de moitié, si, au lieu de circuler sur le pavé, ils circulaient sur l'asphalte. En admettant cette proportion que M. Darcy regarde comme un minimum, on trouverait, en l'appliquant aux chiffres indiqués par M. le préfet de la Seine, et en évaluant à 120 fr. les frais d'entretien et de renouvellement des chevaux (les Compagnies d'assurances demandant à elles seules 10 p. 100 par an de la valeur des chevaux), et 300 fr. en moyenne ceux d'une voiture,

45,000 chevaux à 120 fr. l'un.	5,400,000 fr.
39,000 voitures à 300 fr. »	11,700,000 »
Total.	17,000,000 fr

dont la moitié, soit 8,500,000 fr., représenterait l'économie annuelle réalisée par les chaussées en asphalte au profit des propriétaires de che-

veux et de voitures, en supposant que tout Paris fût asphalté; pour avoir l'économie actuelle, il n'y aurait qu'à établir le rapport entre le total des surfaces asphaltées et celui des surfaces pavées.

Je n'insiste pas sur l'influence que la suppression des cahots peut exercer sur la stabilité des maisons; c'est une opinion personnelle à plusieurs ingénieurs d'une autorité respectable, mais qu'il est difficile d'appuyer par des chiffres.

A tous ces avantages des chaussées en asphalte, avantages incontestés aujourd'hui, on a opposé un inconvénient, qui, s'il était aussi réel qu'on l'assure, aurait certainement une extrême gravité.

On a dit que l'asphalte était impraticable aux chevaux de luxe, et particulièrement aux chevaux de selle, parce qu'il était trop glissant. Je demande la permission d'entrer dans quelques développements sur ce point et de rectifier une erreur à laquelle les apparences ont, j'en conviens, donné jusqu'ici les allures d'une réalité.

Les chaussées en asphalte, lorsqu'elles n'ont pas de trop fortes pentes ou un bombement trop prononcé, ne sont pas plus glissantes que le pavé de grès, elles le sont par conséquent beaucoup moins que le pavé de porphyre; le service municipal s'en est assuré à plusieurs reprises par des comptages faits avec grand soin. Voici un des résultats de ces comptages.

On a relevé pendant deux mois de suite le nombre de chevaux abattus dans la rue de Sèze, pavée en blocs de grès cubiques de 0,23, et dans la rue Neuve-des-Capucines, dont la chaussée est en asphalte comprimé, on a trouvé dans la rue de Sèze un cheval abattu sur 1,308 circulants.

Dans la rue Neuve-des-Capucines, un cheval abattu pour 1,409 circulants.

La proportion est donc sensiblement la même.

Le macadam seul avait, au point de vue du glissement, l'avantage sur l'asphalte. Cet avantage est positif et doit être apprécié par tous les propriétaires de chevaux de luxe; mais, outre que cette supériorité n'a d'intérêt que pour un nombre relativement très-limité de personnes, elle ne saurait être mise en balance avec les nombreux et insupportables défauts des chaussées empierrées. Il n'est pas d'ailleurs bien certain que, même pour les chevaux de luxe, le macadam soit désirable; car, s'il est vrai que les chutes y soient rares, il est vrai aussi qu'un cheval abattu sur une chaussée macadamisée et nouvellement rechargée est ordinairement un cheval perdu.

La chaussée en asphalte n'est pas glissante par elle-même, mais elle acquiert souvent cette fâcheuse propriété, soit par l'importation de la boue qui reflue des chaussées pavées du voisinage, soit par la formation de cette poussière savonneuse provenant du fumier des chevaux, et qui, dispersée par les roues des voitures, finit par enduire toute la surface. Cette poussière, déjà glissante à l'état sec, le devient davantage encore

lorsque le brouillard ou la pluie fine l'humecte et la transforme en une boue grasse qui lubrifie la surface et la rend éminemment propre au glissement.

Rien n'est plus simple et plus facile que de faire disparaître cette boue; un lavage à grande eau exécuté toutes les vingt-quatre heures au moyen des bouches d'arrosage suffit pour en débarrasser la chaussée. Lorsque la circulation est telle, que l'arrosage devienne difficile, on se contente de saupoudrer la surface d'une très-légère couche de sable. Il est à remarquer que la boue du macadam ne rend pas la chaussée asphaltique glissante comme fait la boue du pavé; toutes les passerelles des Champs-Élysées qui sont en asphalte, et constamment recouvertes par la boue de la chaussée empierrée, n'ont jamais donné lieu à aucun accident.

En somme, les chaussées en asphalte, lorsqu'elles sont tenues propres, ce qui est facile, ne sont pas plus dangereuses que les autres. Ceci ressort de toutes les observations, et l'on peut s'en rapporter, pour l'exactitude de ces observations, à la prudence des ingénieurs du service municipal qui les ont faites. Je pense que la frayeur de l'inconnu, une défiance naturelle pour tout ce qui est nouveau, et peut-être aussi les accidents survenus à l'origine des essais, lorsque le système d'entretien était encore à l'état d'étude, ont seules donné naissance à une crainte que rien ne justifie plus, mais qui, comme toutes les craintes sans fondement, ne s'effacera pas de longtemps. Le public est d'ailleurs enclin à se frapper des faits insolites et à leur donner des proportions exagérées, tandis qu'il en laissera passer d'autres très-graves sans y prendre garde, parce qu'il y est habitué; il remarquera un cheval tombé sur l'asphalte, il en parlera comme d'un événement et il en conclura volontiers que l'asphalte est dangereux, tandis qu'en voyant un cheval s'abattre sur le pavé, il ne s'avisera jamais d'en déduire que le pavé est glissant; qu'un effroyable accident de voiture arrive, qu'une diligence roule dans un précipice et s'y perde corps et bien, rien n'est plus ordinaire; depuis deux mille ans, les voitures versent dans les précipices; mais que deux trains se rencontrent, qu'un voyageur y perde la vie, peu s'en faudra que les journaux ne réclament la suppression des chemins de fer.

Il me reste à traiter la question au point de vue financier et à comparer les prix de premier établissement et d'entretien des chaussées en asphalte avec ceux des autres systèmes en usage.

Ici je laisse parler les chiffres.

L'asphalte comprimé, tel qu'il est appliqué aujourd'hui par la ville de Paris, coûte, béton compris :

De premier établissement.	fr. 15 le mètre carré.
D'entretien annuel.	1 25 »
Le pavé en porphyre belge de premier établissement.	18 à 22 »

D'entretien annuel. . . . . de 30 c. à 1 fr. 50 c.

selon le mode de pose du pavé, les joints serrés représentant le *minimum* et les joints larges le *maximum*.

Enfin, le macadam en granit (dans les voies fréquentées) :

De premier établissement. . . . . 7 fr.

D'entretien. . . . . de 2 fr. 50 c. à 3 fr.

Il faudrait ajouter au prix d'entretien du macadam les frais qu'il impose au service des eaux pendant la mauvaise saison par les flots de boue que le balayage envoie dans les égouts et dont il faut ensuite les débarrasser.

Ainsi l'asphalte est plus coûteux d'établissement que le macadam, mais il l'est beaucoup moins d'entretien.

Il est moins coûteux que le pavé de porphyre, mais son prix d'entretien est supérieur.

Il n'est donc pas possible d'établir dans cet ordre d'idée une comparaison très-exacte entre les trois systèmes, et les chiffres que je viens de citer n'ont d'intérêt que combinés avec toutes les autres considérations qui militent pour ou contre chacun de ces systèmes; il n'entre pas du reste dans le cadre de cette note de discuter leur plus ou moins de valeur au point de vue du budget, mon intention étant de rester dans l'étude purement technique de mon sujet.

On s'est inquiété de savoir, en prévision de l'immense consommation que Paris allait faire de l'asphalte, si les mines actuelles ne finiraient pas par s'épuiser. Je crois que toute crainte à ce sujet serait chimérique; la mine du Val-de-Travers et surtout celle de Seyssel, suffiront, pendant bien des années, à l'établissement et à l'entretien des chaussées de Paris; il n'est pas possible de prévoir à quelle époque elles s'épuiseront, ni même si elles pourront s'épuiser, car on ne connaît pas la limite des bancs; mais, dût-on se trouver en présence de cette éventualité, elle ne devrait pas être à redouter, car tout le terrain jurassique, depuis le département du Bas-Rhin jusqu'en Savoie, est certainement très-riche en asphalte; des affleurements se montrent partout; il ne s'agit que de trouver les gisements, et on les trouverait, sans aucun doute, si le besoin venait à s'en faire sentir.

Enfin, pour terminer cette monographie des chaussées en asphalte, j'ajouterai que leur entretien est d'une simplicité telle, que la circulation s'aperçoit à peine de l'embarras que causent les réparations. Lorsqu'une portion de chaussée, soit par une dégradation naturelle, soit par suite de l'installation des tuyaux d'eau et de gaz ou de la construction des égouts, doit être changée, on découpe la partie à refaire et on la remplace par de la poudre chaude que l'on comprime au pilon. On remet ainsi une pièce à la chaussée, comme on remet une pièce à une étoffe.

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J'achève ici cette note, je crois avoir indiqué tout ce qui peut intéresser le système que je me suis proposé de décrire. Je ne me dissimule pas cependant que mon exposé est tout à fait insuffisant pour donner une idée exacte de la pratique, et je crois que la visite des ouvrages en cours d'exécution serait, pour les personnes désireuses de se faire une opinion complète, le plus utile complément du travail que la Société vient d'entendre.

NOTA. — Voir la discussion qui a eu lieu sur cette note dans les séances du 22 janvier et 5 février, pages 38 et 42.

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PARIS UNIVERSAL EXPOSITION, 1867.

REPORTS OF THE UNITED STATES COMMISSIONERS.

REPORT

ON

ASPHALT AND BITUMEN,

AS APPLIED TO THE CONSTRUCTION OF

STREETS AND SIDEWALKS IN PARIS;

ALSO TO

TERRACES, ROOFS, ETC., AND TO VARIOUS PRODUCTS IN THE EXHIBITION OF 1867;

WITH OBSERVATIONS UPON

MACADAMIZED STREETS AND ROADS,

BY

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CIVIL ENGINEER.

WASHINGTON:
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SECTION I.

ASPHALT AND BITUMEN, AS APPLIED TO THE CONSTRUCTION OF STREETS AND SIDEWALKS IN PARIS.

INTRODUCTORY REMARKS.

Asphalt is used in Paris chiefly in two different forms: first, the natural rock, unalloyed, with which streets are made; second, a mixture of asphalt with bitumen and fine gravel for the construction of sidewalks.

The rock is found principally at Seyssel and Vale-de-Travers, where it can be procured at $7 90[1] per ton. It is transported to Paris by rail or canal, and is sold here for $14 or $16 per ton. A few hundred tons of rock have been transported to the United States from France at different times.

The mixture above spoken of is called mastic of asphalt, and is manufactured in many places in France. At Seyssel a manufactory is established, producing 40 to 50 tons of mastic of asphalt per day.

The term "asphalt" or "asphaltic rock" is applied only to a species of limestone impregnated with bitumen.

"Bitumen" is a dark, viscous substance of organic origin, which impregnates bituminous limestone, flows from various rocks, or is found in natural deposits.

"Mastic of asphalt" is a composition formed of bituminous limestone (asphalt) reduced to powder and mixed with a small quantity of bitumen.

This mastic, with a further addition of bitumen and fine gravel, is used for sidewalks.

DESCRIPTION AND COMPOSITION OF ASPHALT.

Asphalt, or asphaltic rock, is a limestone of natural formation, composed of pure carbonate of lime impregnated with bitumen, and found in numerous localities forming strata of various extent.

Color: dark chocolate, nearly black.

Fracture: fine-grained, irregular, without cleavage planes. In some formations the fracture in the direction of stratification is dark and mealy, but in the opposite direction it is drier and the color is lighter.

Asphalt is affected by changes of temperature. At a low temperature it is hard and sonorous, and under the hammer breaks like common limestone. At the temperature of high summer heat it yields to the blows of the hammer, becomes flattened, and is easily reduced by repeated blows to a paste; and at the temperature[2] of 140° or 160° it commences

[1] The prices given in this report are in gold.

[2] All temperatures mentioned are expressed in degrees of Fahrenheit.

to disintegrate and crumble. Above 212° the disintegration is complete. The average specific gravity is 2.235, (water being 1.000.)

VARIETIES OF ASPHALT.

The structure of asphaltic rock varies in different localities; the best localities are fine-grained, homogeneous, free from interposed particles of limestone not impregnated with bitumen. The fracture of this quality presents the same aspect whether broken parallel or perpendicular to the stratification. The aspect of all formations is not uniform; some rocks present darker and lighter spots like the skin of a tiger. Others contain numerous shells, of one-twentieth or one-tenth of an inch in diameter, filled with crystals of carbonate of lime impregnated with bitumen; the crystals are often large, rhomboidal, with cleavage planes of one-twenty-fifth or one-tenth of an inch. All those varieties constitute excellent asphalt, provided the whole mass be thoroughly penetrated with bitumen.

The rock may be uniformly impregnated, but if it contains less than six per cent. of bitumen it is too poor to be worked. The rock may be cracked in numberless directions, and disintegrated in a manner to admit of the absorption of bitumen, and the fracture may present the fine dark color of good qualities; but if this be crushed to powder or examined by the microscope, it will be discovered that the impregnation is only apparent and owing merely to infiltration and absorption, which gives color and coating only to the granules.

The conditions necessary to perfect impregnation have been the subject of fruitless speculations, the most plausible of which is the theory that reduces the bitumen to the condition of gas, and supposes a high temperature and great pressure, which results in the complete saturation of the rock without disintegrating it.

The rock may also appear rich in bitumen, but contain elements of clay, which not being impregnated like the carbonate of lime, destroy the homogeneity of the formation. The fissures seen in side-walks are often attributable to this cause, but the presence of clay is easily detected.

Some beds of asphalt contain an oily element, which renders them too fat and prevents the solidification of the mastic; but rock of this kind may be freed of this oil by distillation, and then becomes fit for use.

Formations of asphaltic rock exposed to air lose their bitumen to a certain depth, and then present on the surface the ordinary appearance of white chalk formations; but experience has shown that after 40 years of exposure the evaporation of bitumen does not extend below the $\frac{1}{100}$ of an inch from the surface.

COMPOSITION OF ASPHALT.

The chemical composition of asphalt varies in the proportion of limestone and bitumen, being generally from 7 to 8 per cent. of bitumen, and 93 to 92 per cent. of limestone. The qualitative analysis gives nearly identical results everywhere.

Very pure varieties, such as those of the Val-de-Travers in Switzerland and of Seyssel in France, contain absolutely nothing but carbonate of lime and bitumen.

Less pure varieties, such as those in Auvergne, (France,) which is a volcanic region, contain other elements, which are common to the neighboring rocks, such as clay, silica, magnesia, iron, &c. The asphalt of Auvergne contains, in addition, traces of arsenic.

A rigorous analysis applicable in general, therefore, cannot be given; each bed may present different results. As a rule, it may be stated that asphaltic rock is quite free from foreign matters.

Proportion of bitumen.—To ascertain the proportion of bitumen in asphalt, bituminous sands, asphaltic mastic or other bituminous bodies, the following method may be used:

Reduce a small proportion of the bituminous body, say 20 ounces, to powder; expel the water by exposing the powder to a current of air heated above 200°, but below 300°, to avoid the escape of essential oils from the bitumen; stir the powder freely and weigh a portion of it, say 10 ounces, upon which pour 10 ounces of pure sulphide of carbon. (Impure sulphide of carbon contains sulphuretted hydrogen, which may attack the limestone and sulphur, which would also falsify the weight.) Stir the mixture with a glass rod, let it settle, then pour off the sulphide of carbon, which will be charged with bitumen, upon a filter which has been weighed. Pour another equal quantity of pure sulphide of carbon upon the powder, drain it off again, and filter as before. Repeat this operation until the limestone powder left in the glass becomes white, and the liquid drained off retains no longer a brownish tinge. Dry the powder and weigh it together with the filter; deduct from the weight of both the weight of the filter; the remainder is the weight of limestone powder. And the difference between this weight of powder and its weight of 10 ounces will show the quantity of bitumen which has been extracted.

The operation may be verified by evaporating the sulphide of carbon in water at 160°; the sulphide of carbon being vaporized at 118°, the residue thus obtained will be the bitumen, which should equal in weight the loss sustained by the powder in the previous operation.

ASPHALT STREETS AND ROADS.

STREETS.

The remarkable properties of asphaltic rock permit of its being used unalloyed for streets. At the temperature of near 160° the bitumen which impregnates the molecules of carbonate of lime begins to yield, and the particles separate and crumble to a mass of brown powder at 212° to 280°. If this dust, while hot, be compressed in a mold and allowed to cool in its new form, the molecules will adhere, and the rock will recover the aspect, hardness, and all the qualities it originally pos-

sessed when extracted from the quarry. If the hot powder, instead of being placed in a mold, be spread about two inches thick on a hard foundation, and pressed or packed by a hot iron pestle used with the hands, or by a roller, and allowed to cool, the surface will immediately solidify, forming a monolithic crust, identical in all respects with the primitive rock, as if it had been taken in that form from the original bed. Such is the principle on which roads of compressed asphalt are made.

The first indication of this method was due to accident. Fragments of asphalt, dropping from the carts which transported it from the quarries along the road, became heated by the sun and were crushed to powder and compacted by the continued passage of carts, until they formed a hard, smooth track. The phenomenon thus presented led by many experiments to the perfect method of rock-road now in use, which suffers no material change from the influence of the sun.

In 1854, the first street of compressed asphalt that was established in Paris covered 960 square yards. Since then these roads have steadily increased and are laid in the most frequented thoroughfares.

	Square yards.
Up to 1866, the streets of compressed asphalt covered a surface of	96,000
During 1867, there were laid in Paris	54,000
And in the suburbs	30,000
Total surface covered to to-day	180,000

The contract of the Cie Générale des Asphaltes with the city of Paris covers at present at least 96,000 square yards of streets of compressed asphalt to be laid in 1868–1869.

CONSTRUCTION OF ROADS.

The construction of roads comprise the following operations: Formation of road-bed; crushing the asphalt; roasting the asphalt; transporting and laying the hot powder; packing the road.

Formation of road-bed.—As soon as the earth has been beaten down so as to become compact and solid, it is covered with a layer of concrete (made of 90 parts of gravel and 40 parts of mortar) 2½ inches thick, which is allowed to become hard and perfectly dry before receiving the asphalt.

The first elements of a road-bed are good surface drainage and good under drainage. The damage and disturbance of all roads by frost are diminished in proportion to the perfection of the surface and under drainage. The asphalt roof or covering being impervious to water, there is no vertical absorption from rains, and if the drainage is perfect there will be no lateral absorption. Consequently the road-bed will remain dry at all seasons, and the frosts of winter will produce no upheaval nor disturbance of the road-bed, as it contains no moisture.

Crushing the asphalt.—The asphalt is brought from the quarries in

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blocks and fragments of all sizes, like ordinary building stone. The blocks are crushed between rollers with steel points, to the size of an egg, and the fragments are then passed between smooth rollers, which reduce them still further. The debris is now ready for roasting. There are various methods of roasting adapted to large or small establishments.

Furnace for roasting asphalt.—The ordinary roasting furnace consists of a concave surface of sheet-iron open to the air, resting on walls of bricks, with a furnace underneath. (See Plate I, Figs. 1 and 2.) The sheet-iron pan measures 2 yards 7 inches by 3 yards 11½ inches. A charge of crushed asphalt of about 1,700 pounds is thrown upon the pan, and during the process of roasting it is shovelled and turned by two men, to render the roasting equal throughout, care being taken in the shovelling not to throw up and expose the powder too much to the air. After an exposure of an hour and a half to a gradually increasing temperature, which rises to 250° or 300°, the disintegration is complete and the powder ready for use. Particular care and some experience are required in roasting, that each portion may be exposed to a temperature as nearly equal as possible, and sufficient to produce a uniform and complete disintegration of particles throughout the mass. In cold weather allowance must be made for increased loss of heat in transporting the powder to the road-bed, that it may not become too cool for consolidation before it is laid and packed. Uniform and equal roasting are important; if any portion of the mass is not sufficiently heated to produce complete disintegration and softening of the oils, that portion will not concrete when laid; also, a portion of the moisture which should be dispelled will remain and prevent the oily substance from cementing the particles. If, on the other hand, any portion be overheated and burnt, the cementing substance will be expelled and leave a dry powder, destitute of the quality of cohesion. Defects which appear in asphaltic roads soon after they are laid often result from this cause.

Second method of roasting.—In this method of roasting an apparatus on the principle of a common coffee-roaster is used. (See Plate II, Figs. 3, 4, 5.) A horizontal cylinder revolves within a stationary cylindrical enclosure. The air in the intervening annular chamber is heated from a furnace beneath. The revolving cylinder, charged with about 4,400 pounds of crushed asphalt, in its rotary motion over the fire, roasts in succession every portion of asphalt regularly. Various gases escape at the orifice *a b e d*, which is partly closed by a thin iron safety lid *e*, which gives way in case of any sudden pressure. At the end of an hour and a half, when the vapor ceases to rise, the roasting is finished. The furnace beneath, which rests on wheels running on rails *f*, is then withdrawn, and a cart is brought in its place; the bolt *g* is drawn, and the powder discharged into the cart. The lid of the cart is closed to retain the heat, and the cart is moved off with the load; the furnace is brought back and the process of roasting asphalt recommences.

Transporting and laying the hot powder.—Formerly asphalt was roasted

by the side of the road to be laid, producing smoke and vapor which disturbed the circulation and was inconvenient to the neighborhood. It is now roasted in large establishments in the suburbs and transported in carts lined with sheet-iron, and in a distance of three or four miles in summer will not lose over 10° or 12° of heat, and in winter 30° or 40°.

The asphalt must not be laid on a moist bed. If the surface is moist the heat of the powder vaporizes the moisture, and the steam escaping through the powder prevents the complete cohesion of the particles, and the road will be out of condition in a few months.

If it is impossible or inconvenient to wait for the drying of the concrete bed, it must be dried by artificial means, such as covering the surface with hot ashes or hydraulic lime for a few minutes.

The bed being in condition, the asphalt is spread upon it uniformly, giving it a coat of 2 or 2½ inches in thickness, to produce a final crust of 1½ to 2 inches thick.

Packing.—The packing then commences immediately by hand with *hot-irons* or *pestles*, with a smooth under-surface, which are applied lightly and uniformly to the surface.

The packing of the edges is done with rectangular irons, (see Plate III, Fig. 6,) and that of all other parts of the service is done with circular irons, (see Fig. 7.)

When the crust of asphalt has been compressed to its definitive thickness, a thin coat of dry sifted powder is spread over it to fill up inequalities, and the whole surface is then smoothed over with a flat iron, (see Plate III, Fig. 8,) which has been heated nearly to a red heat.

While the asphalt is still hot, smooth iron rollers are passed over it, the first weighing about 440 pounds, and the second 3,300 pounds, which completes the packing.

The process of rolling is sometimes omitted, and it is still doubtful whether it adds anything to the solidity of the coat resulting from the immediate concretion under the smoothing irons.

The packing thus completed, the road may be opened in a few hours to the circulation of vehicles of all kinds.

Resuming and continuing the work.—To resume the work of the previous day, the edge of the solid asphalt must be cleared of dust and loose particles and a layer of hot asphalt thrown upon it to heat it; when the edge is sufficiently heated the layer thus thrown down is removed and returned to the furnace for reheating; and as this removal takes place, a hot layer from the carts is thrown down and spread, and the packing immediately commenced as before described.

The edges of the old and new work thus unite perfectly, and no joint or seam remains visible.

It is unnecessary to interrupt the circulation of a wide street to cover it with asphalt. The process is carried on upon one side of the road, and when that is completed and delivered to circulation the other side is commenced. The joint or seam along the axis of the road being formed

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in the manner described for continuing the work from one day to another, no vestige of it remains if well done.

The use of compressed asphalt is not limited to the construction of roadways. Courtyards of railway stations, hotels, private houses, quays, and crossings for foot-passengers from one sidewalk to another, are often paved with compressed asphalt, and without even interrupting circulation during the process of construction.

ADVANTAGES OF ASPHALT ROADS.

Constant wear for a year does not reduce the surface more than $\frac{1}{25}$ of an inch; consequently these roads produce neither mud nor dust.

They diminish draught to a very low point. They are almost noiseless; carriage-wheels roll along without being heard, but foot-passengers are warned by the audible tramp of the horses' feet.

The jar and straining of carriages is almost annihilated, and their wear from these important causes becomes nearly imperceptible.

The roofing of the road-bed being impervious to water, the bed becomes harder and drier, and once made is imperishable. These roads, when completed, are absolutely free from bituminous odor.

Objection has been made that asphalt roads are slippery in wet weather; but this objection is ill-founded, if the surface be nearly horizontal, with just sufficient convexity to cause water to flow freely and wash the surface clean.

In proof of this, direct observation shows that on parallel streets, one paved and the other of asphalt, 1 horse in 1,308 falls on the paved street, and only 1 in 1,409 on the asphalt, thus giving the superiority to asphalt roads.

A noteworthy advantage is the facility with which repairs are made by simply cutting away the damaged portion and replacing it by new hot powder.

Cost.—Asphaltic streets in Paris cost, on an average, (concrete foundation included:)

Per square yard	$2 50
And for annual repairs	25

I add the cost of other streets at Paris for comparison: Pavement of hard stone, (Belgian porphyry:)

First cost, depending on the size of the stone, per square yard	$3 00 to $3 67
Annual repairs, depending on the size of the joints between the stones, per square yard	08½ to 25
Macadamized streets:	
First cost, per square yard	1 17
Annual repairs	42 to 50

This does not include the great expense of watering and cleaning the surface and removing the mud from the sewers.

Thus the first cost of asphalt streets is greater than that of macadam-

ized streets, but the cost of repairs is much less, while the first cost is less than that of the Belgian pavement, and the expenses of repairs greater.

MASTIC OF ASPHALT.

The substance known by the name of mastic of asphalt, of which sidewalks are made, is composed of asphaltic rock reduced to powder and mixed with bitumen, to which may be added sand or gravel.

The asphaltic rock used for mastic is usually of inferior quality, containing less bitumen than that which is used for roads.

SOURCES AND COMPOSITION OF BITUMEN.

The bitumen employed in Paris is derived chiefly from the following sources: 1. From bituminous molasse (a species of sandstone, or a sand and limestone, impregnated with bitumen) by a process of boiling in water, which releases the bitumen. 2. From bituminous sands, found plentifully in the centre of France and elsewhere. 3. From natural deposits of bitumen, as in Trinidad, &c.

Tar obtained by distilling the bituminous schist or boghead from Scotland; also, coal-tar, produced in the manufacture of gas, have been used as a substitute for bitumen, but they are considered to give poor results.

Composition and properties.—Bitumen is composed of several carburetted hydrogens more or less oxygenated. These carbides can be separated by vaporization. The following represents the average composition of bitumen:

Carbon	85
Hydrogen	12
Oxygen	3
Total	100

From whatever source derived, superior bitumen exhibits the following properties: Its *color* is brilliant black with a reddish tinge. The reddish tinge augments when bitumen is softened and drawn into threads. The *fracture* is conchoidal, at a low temperature. Below 50° it is solid and brittle; from 50° to 70° it is elastic and begins to soften; from 70° to 90° it becomes soft and pasty; from 90° to 100° viscous; and at 110° or 120° it melts. Its specific gravity is 1,025, (water being 1,000.) The *odor* is empyreumatic and free from the noxious smell of coal-tar.

FABRICATION OF MASTIC OF ASPHALT.

1. Asphaltic rock is broken into fragments by hammer or grinding cylinders, and then pulverized If it is fat and rich in bitumen, it is pulverized by exposure to heat in an oven, or placed in an iron case and subjected to the action of steam at a pressure of four atmospheres. If the rock is dry and contain little bitumen, it costs less to reduce it to powder by crushing cylinders.

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2. The powder is sifted through horizontal cylindrical bolters of wire-gauze of one-tenth inch meshes.

The following dimensions of a bolter are suitable:

Length of wire-gauze portion	5 feet.
Diameter at the entrance.....	1 foot 6 inches.
Diameter at the exit.....	2 feet.
Diameter at the axle.....	2 inches.
Size of iron frame framework.....	12 inches by 12 inches by 2½ inches.
Number of revolutions per minute.	25

3. A quantity of bitumen (about 330 pounds) is placed in an iron boiler, semi-cylindrical, with a fire under it. (See Plate I, Figs. 9, 10.) As the bitumen becomes heated and liquefied, the powder of asphalt, brought from the bolters, is thrown in from time to time, till the amount of asphalt employed reaches 4,400 pounds. A revolving shaft with spokes (E) passes horizontally through the semi-cylinder, which stirs up and mixes the compound, until the whole mass becomes homogeneous and of the consistency of paste. It is then drawn off into moulds (see Plate III, Fig. 11) holding about 55 pounds each, where it is left to cool and form solid blocks. The mastic thus formed is ready for sale and transport to all places. During this operation about seven per cent. of water and essential oils will be evaporated, leaving 4,400 pounds of mastic.

Good mastic should contain 18 per cent. of bitumen; consequently the quantity of bitumen added to the asphalt must be regulated by the quantity inherent in the rock.

Cost.—The cost of mastic in Paris is $1 09 per 100 pounds.

BITUMINOUS SIDEWALKS.

Bituminous sidewalks cover in Paris a surface of 1,430,896 square yards. They are made of mastic of asphalt, with an addition of bitumen and fine gravel, in the following proportions:

Mastic.....	100 pounds.
Additional bitumen.....	5 to 6 pounds.
Fine gravel	60 to 70 pounds.

Fabrication.—Place three per cent. of the bitumen in the mixing cylinder, (see Plate I, Figs. 9, 10,) and stir with an iron puddling bar, (see Plate III, Fig. 17,) and when this is hot and liquid add ¼ of the mastic broken in lumps; this being melted and mixed add one per cent. more of bitumen, and another ¼ of the mastic, and in due course the remaining one per cent. of bitumen and ¼ of mastic.

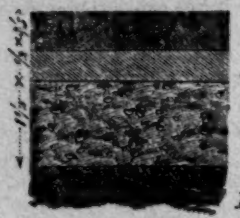
When this mass is melted and well mixed add half the gravel, and after an interval of heating and mixing add the remaining half. Clean, dry, silicious river sand is best; the proportion to be added is not absolute; it is usually thrown in as long as the mass retains the proper mortar-like consistency, and no longer. A large proportion of sand or gravel is advantageous in a hot climate, as the sidewalk will be less affected by the rays of the sun.

The temperature in mixing should range from 300° to 400° for two or three hours, the mass being all the while agitated by the revolving spokes, when the mixture will be ready for use.

Transportation.—It is then drawn off into a portable sheet-iron boiler, on wheels, (see Plate III, Figs. 12, 13,) supplied with a small furnace, and revolving shaft and spokes; a moderate fire is required on the way to keep the mastic in a semi-liquid state, and the shaft is occasionally turned by hand to avoid the unequal heating of the mastic.

A portable boiler like the one represented will carry enough to cover 31 square yards of ½ inch thick.

It weighs when empty 2,630 to 3,300 pounds; when full, 4,650 to 5,500 pounds. The cost in Paris is $475.



Sidewalk upon hard soil.

Sidewalk upon loose soil.

Foundations.—The ground should be thoroughly drained, and if it is hard a layer of concrete 1½ inch thick is first spread upon it; and then a layer of mortar ½ an inch in thickness is spread on the concrete. If the ground is loose it should be beaten till it is compact, and then covered with a layer of concrete 3½ inches in thickness, and upon this a layer of mortar ½ inch thick; this formation should be left to become completely dry before the mastic is applied.

Laying.—To secure uniformity and facility in spreading the mastic on the bed a couple of iron rods or rules are used, of the thickness of the intended coat, usually ½ of an inch. These are laid across the sidewalk parallel to each other, with a convenient distance between them, thus forming a gauge for the workmen. The mastic being of the consistency of ordinary mortar and brought hot from the portable boiler in an iron ladle, (see Plate III, Fig 16,) is dumped on the ground in small charges between the rods, and is immediately spread over the surface with wooden trowels. (See Plate III, Figs. 14, 15.)

One belt being thus laid, another is commenced while the first is still hot; the edges of the first and second belt, if kept clean, will readily unite, and the work is then continued.

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The surface of the coat being smoothed by wooden trowels, a light shower of dry fine sand is sprinkled on it while it is still soft, to produce a more stony surface, but the mastic being already saturated very little of the sand will be retained.

The cooling and hardening are rapid, and in a few minutes the sidewalk is ready for use.

To resume the work of a preceding day, a process similar to that described for roads of asphalt is necessary, in order to soften the edges of the previous belt, and produce a complete soldering of the edges of the successive belts.

The sketches represent the disposition of the mastic next to the wall and the curb-stone.

Cost.—The cost of the crust of mastic applied to a surface of at least 1,000 square yards, of ¾ inch thick, varies in different towns of France, per square yard, from 67 cents to $1 12, being in Paris 75 cents. If the foundation of concrete and mortar be included, the cost of the sidewalk varies in Paris, per square yard, from 92 cents to $1 12 according to the thickness of concrete. Annual repairs are estimated at, per square yard, five cents.

VARIOUS USES OF ASPHALT AND BITUMEN.

Asphalt and bitumen have been used in many ways from time immemorial; they are found in abundance in the Assyrian and Egyptian remains, and are still among the best materials for constructions of numerous kinds, some of which will be briefly noticed.

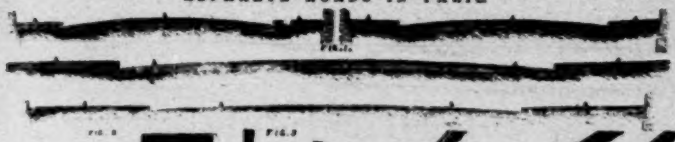
FOUNDATIONS IN DAMP GROUND.

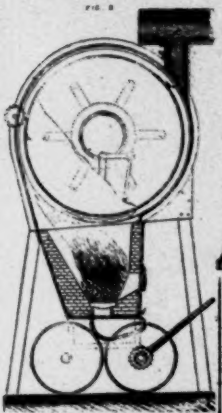
The ascent of moisture in the walls of a building on wet ground can be cheaply and effectively prevented by a layer of asphalt between two courses at the base. (See Plate I, Fig. 11.)

A remedy may be applied to a building already erected by digging a trench round the foundations and lining the outer side with planks, leaving a space of three to four inches between the plank and the wall, and filling in the space with hot concrete of mastic and gravel, and the planks are then removed and their place filled with earth.

MAP(S) IS/ARE TOO LARGE TO BE FILMED

ASPHALTE ROADS IN PARIS.





For more than sixteen years the use of asphaltes as a material for road construction has been making favour in France, and at the present time a street area of nearly 150,000 square yards has been covered with that material in Paris. The asphaltes employed in a mechanical state are prepared with bitumen, and obtain in commerce the names of Seyssel and Pyrimont, in the department of Seine and Loire, the quarries being situated on the right bank of the Rhône. The rock taken from these quarries disintegrates under very moderate heat, owing to the melting of the bitumen, and when raised to a temperature of 212° it falls into dust, which, however, is so plastic that it can be moulded to any desired shape, but it will retain, and gradually recover its original hardness when cool. The question of found vents involved attention only for the construction of cement for fastening long before the adoption of coatings made non-conducting, and it was only through accident that attention was directed to it as a road material. In the course of transporting the bituminous rock from the quarry to the cement works, the fragments which fell from the carts to the ground were flattened and consolidated more by the wheels, subjected by the rain, and ultimately hardened into an admirable, though irregular, road surface.

Profiting by this chance lesson one M. Morian, a Swiss engineer, laid down in 1843, a somewhat imperfect asphaltic road on Val de Travers, but which, nevertheless, is still in a state of perfect preservation.

In 1852, M. Darcy, Surveyor-General of Bridges and Roads, in a report addressed to the Minister of Public Works, pointed to apply it immediately on a portion of Paris boulevard.

However, it was only in 1854 that, under the superintendence of M. Hamelin, chief engineer, and M. Vaudry, ordinary engineer of the municipal construction, the first asphaltic road was constructed in Rue Bergère, Paris, on the recommendation of a road which had only lasted a few months, and to which bitumen had been employed. Since then the road workers of the Rue Bergère, if we except the pavilion in front of the Rue du Conservatoire, which is made out of cast asphalte, has never been repaired.

In 1869 the pavement of the Rue Neuve des Petits Champs was taken up and asphaltic laid down in its place. The weather on the days was extremely unfavourable, and the labour formidable was dearly when the men assembled, but on; the consequence was that the asphaltic did not become properly consolidated, and after having formed a mass much like asphaltic, the pressure of vehicles shortly broke the surface up into holes and ruts, so that it became necessary to reconstruct the road in favourable weather, and with a better foundation. This was an important example, pointing out the necessity of observing the two capital conditions necessary for the preservation of a good road of this description.

The crushing of the material is the first operation in making an asphaltic road. This is effected in a crushing mill, the hoppy having been previously reduced, generally by hand, to pieces of about 3 in. cube. The crushing mill consists of two cylinders, one of which is made to revolve within the other by suitable driving. Immediately in a position under the cylinders, from which the material is delivered, is placed a sieve, one of the meshes of which is about 1 in. square, and the other about ½ square, and the upper sieve is formed of bars 1 in. apart, over which the fragments to be crushed are passed, and the pieces taken up by a card with an iron back, into which the wheels seem to revolve. As soon as the cards are condemned to the place of deposit their contents are removed and spread over the surface of the ground, being turned from time to time, and consolidated by hot and cold ramming tools. In Fig. 1 are shown the principal methods of ramming: A, represents the rammer, B, the labour, and C the resulting soil.

The road being worked here by people from, the labour is laid down upon it, and the asphaltic being spread over it simultaneously by means of the rods (Fig. 2). In addition to these a tool, similar to a hoe, is used, as shown in Fig. 3, a rare and useful of the instrument. It consists principally of a roller within which is placed a hot fire of charcoal. A solid roller of the ordinary form is afterwards employed.

THE LONDON GAS PROBLEM.—In the speech of the chairman of Messrs. Sir Wm. Thomson, in the Court of Common Council of that company, on January 27 1870, it was stated that the profits of the Phœnix Gas Co. for the year, although reduced to less than 10 per cent. on the capital, left 10s. 6d. which was carried to the reserve fund, and that the company had expended in the year £20,000 in the purchase of lime of worthless quality, and of good quality; that coal is now consumed by the company which yields 12 per cent. of cannel, and 25 per cent. of improved gas; of cannel, and 25 per cent. of Boghead, from the Lothians; and that the meters worked are instructed by the company of Hargreave and Bowman, which at the same time all the meters of the London companies are adopting and which are working with high wages. It is stated, the chairman said, by the Gas Light and Coke Co., that the dividend for the twenty-first half-year, the commencement of the new Act, will be at the rate of £5 per cent. per annum. At the present time, when the public are discussing the question of the value to the mother country of Her Majesty's colonial possessions, it is satisfactory to remember that the little settlement of Singapore, and the Queen's ships in the China waters, would have been unable to carry on their operations without the supply of coal from Labuan, the commercial results of which, for the year 1869, are highly satisfactory. At the meeting of the Legislative Council of Singapore, held on the 7th of January, the Governor, Colonel Cavenagh, read the report of the Labuan Coal Company, showing a profit, for the year 1869, of £7,000, after paying a dividend of 10 per cent. to the Peninsula Government of Selgon and to the British, and proposing to distribute the remainder of the profits of coal trade as the mutual interests in Labuan and the coal trade in the China Sea. Indeed, the recent opening of the new China ports, especially the Yangtsze, has given a great impetus to the demand for Labuan coal, and it is possible to anticipate other results which would follow the establishment of coal depots, and the consequent facilities for steam navigation, in the Straits of Malacca and the Indian Archipelago. These considerations have induced me to give all the assistance in my power to the development of the coal resources under the control of the colony, and I am informed that the steamers used there have given great satisfaction. I have also directed my attention to the question of the supply of coal to the Australian colonies, and I am happy to state that the Peninsula and Oriental Company have undertaken to carry out the arrangements which I have made for the supply of coal to the Australian colonies, which will have a most important effect in the development of the coal trade of Labuan. I have also directed my attention to the question of

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MINUTES OF PROCEEDINGS

OF

THE INSTITUTION

OF

CIVIL ENGINEERS;

WITH OTHER

SELECTED AND ABSTRACTED PAPERS.

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No. 1,379.—"The Applications of Asphalt." By Ernest Chabrier, Civil Engineer, Paris. (Translated by W. H. Delano, Assoc. Inst. C.E.)

Early Studies.

The nature of asphalt was first seriously discussed in a report by M. Leon Malo, C.E., published in the Annales des Ponts et Chaussées in 1861.[1] This report, written after the author had resided for several years at the mines of Seyssel, in the capacity of manager and superintendent, passed through several editions, and latterly formed the basis of a volume, published in Paris, in 1866, which is the only complete work on the subject.

Following the precedent of M. Malo, the word "asphalt" will be used to designate bituminous limestone, although scientific men regard asphalt as being synonymous with the matter impregnating the limestone, viz., bitumen.

Asphalt is pure carbonate of lime naturally impregnated with bitumen in very variable proportions; but which for road-making should be limited to between 7 and 12 per cent. It is found in beds, frequently of great extent, for the most part of a lenticular shape, from 23 to 26 feet in thickness, and sometimes separated by other beds of entirely white limestone, the nature of which seems to be the same as that of the limestone impregnated with bitumen. It takes an irregular fracture, without definite cleavage. The texture and grain vary with the layers. The grain should be regular and homogeneous, not too close. Exposed to the atmosphere, asphalt gradually assumes a grey, almost a white tint, caused by the bitumen evaporating from the surface and leaving a film of limestone.

History.

In a pamphlet published in 1721, a Greek professor, Eirini d'Eyrinys, mentions the discovery he had made, ten years before, in the Val de Travers, canton Neufchatel, of a mine of asphalt similar to the beds of that substance existing in the valley of

[1] *Vide* 4e Série, 1er semestre, tome I, p. 69.

Siddim, near Babylon.[1] He enumerates at length the advantages of this substance; regarding it as a panacea for human ills, and at the same time as a substitute for mortar in buildings. He states that its employment as cement is antediluvian, and in support of his assertion cites the Book of Genesis, ch. vi., v. 14, where in relation to Noah's Ark it is stated, "and shalt pitch (asphalt) it, within and without with pitch (asphalt);" and, again, ch. xi., v. 3, "and slime (asphalt) had they for mortar." He does not hesitate to attribute the historical resistance of the Babylonian buildings to the employment, as mortar, of asphalt from the valley of Siddim; and asserts that the walls of the famous hanging gardens of Babylon were coated with asphaltic mastic, and that the Tower of Babel itself would not have held together without this substance.

The use of asphaltic mastic tends to justify these somewhat enthusiastic hypotheses, and it is difficult to explain why no trace of its employment should be found amongst the western nations. The details given by D'Eyrinys on the curative properties of "asphaltic balm," both for men and for animals, are very curious, but less interesting than the advantages claimed for the use, in buildings, of asphaltic mastic, which he calls natural cement. He cites, with a thorough conviction of its success, instances of works carried out with it, as cisterns, jointing of paving stones and flags, coating of terraces, &c. It would, however, appear that his successors in the working of the Val de Travers mine contented themselves with extracting asphalt for medicinal purposes, disregarding its merits as a material for paving, though this was afterwards destined to be its principal application.

Until the end of the century only the extraction of bitumen was thought of, as is proved by the concession made by the French Directory in the year V. of the Republic (1797), to a man named Secretan, of all the country situated between Seyssel and Bellegarde, a tract of about 14 miles in length by 1½ mile in width on both banks of the Rhone. Secretan had certainly no other object than to extract the bitumen from the bituminous earth and sandstone, from which it is more easily separated than from the limestone, as is proved by the state of the works at that time; consequently when, later, the employment of asphaltic mastic and the quarrying of the bituminous limestone began to increase, many disputes arose as to the terms of the concession. It was claimed that no right to quarry the limestone existed; the word "mine"

[1] "Dissertation sur l'Asphalte, ou Ciment Naturel." 8vo. Paris.

was even disputed, only open workings were allowed. A lawsuit was the result, and it was not until 1845 that the question was resolved by a decision of the Council of State, which maintained to the concessionary the title of mine, and the right to extract limestone and bitumen, notwithstanding the contrary opinion of the minister. In 1834 M. de Puvis, in the "Annales des Mines,"[1] furnished particulars of what was being done at Pyrimont for the manufacture of asphaltic mastic. Without entering into a subject so new, and without inviting his colleagues in other parts of France to the discovery of similar seams, the author simply gave expression to his doubts, and noticed the heavy expenses of starting works. He recorded, however, the confidence which was already felt in the results of the asphaltic mastic footpaths of the Morand Bridge at Lyons, though the price of bitumen was at that time 800 francs (£31 15*s.*) per ton, whereas the price is now 300 francs (£11 18*s.*) per ton, and the mastic which was then sold at 140 francs (£5 11*s.*) per ton is now sold at 70 francs (£2 15*s.* 6*d.*) per ton. However slowly the natural cement of Eirini d'Eyrinys came into general use, the results were such that engineers did not fail to notice them, and to aid in the development of such remarkable qualities; but speculators intervened, and led the public into acts of folly. As soon as the first footpaths were made, it was maintained that all towns would be paved with this new material.

The first, and perhaps the only inquiry by an engineer at that time into the subject of asphalt then appeared, but it referred to mastic instead of bituminous limestone. Analysis proved the composition to be limestone and bitumen, and this enabled an imitation to be produced. A panic then ensued, which led to the breaking up of the asphalt companies. The remnants of these various undertakings did not agree to amalgamate their interests until the formation, in 1855, of the General Asphalt Company, the management of which being confided to a civil engineer, led to the engagement of another civil engineer, M. Malo, as manager of the mines at Pyrimont. By prudence, in spite of low prices, which the successive opening of railways alone made bearable, operations were begun, and from that moment must be dated the regular development of the asphalt industry.

Mechanical apparatus superseded manual labour; the rock was quarried according to the most approved rules of mining, instead of being simply dug where it cropped up. The primitive method

[1] *Vide* 3e Série, tome 6, p. 179.

of mixing the mastic in small open cauldrons, and thus subjecting for weeks the inhabitants and the luxurious portions of the city to its noisome fumes, was abandoned, and means were found of transporting the mastic hot and ready mixed to the work, so that it could be applied at once. Besides these modifications, particular attention was paid to the process, then quite new, of applying compressed asphalt, which allowed of the employment of the bituminous limestone in its natural state without admixture.

A trial on a small scale had been made in Paris in 1854, under M. Vaudry, then roadway engineer; and another on a more important scale was made at the expense of the Company in the square in front of the Palais Royal in 1858. At this time the Rue St. Honoré had a traffic of thirteen thousand one-horse vehicles daily, upon a width of roadway of 8 mètres (26 feet). The result was satisfactory, and the municipality decided to reserve, for this mode of paving, the streets comprised between the Madeleine and the Halles Centrales along the Rue de Rivoli. Machinery was prepared in proportion to the needs of the experiment, but the scheme was nearly jeopardised by the necessity of completing all the subterranean works of drainage, &c., before the asphalt was laid down. Thus the asphalt was applied upon soil recently disturbed to the depth of 10 feet to 12 feet. This induced instability of the subsoil, involving the breaking up of the layer of asphalt, 2 inches thick, which could not resist the subsidence of the foundation. Profiting by the experience thus gained, engineers in London insisted upon a thick layer of concrete for a foundation, which served to consolidate the soil.

Geological History of Asphalt.

The geological phenomena which produced asphalt have been little studied by men of science. The first theory is that bituminous vapours, meeting seams of limestone under favourable conditions of pressure and temperature, have penetrated the stone and become condensed therein. The examination of the beds would seem to negative this theory. Seams of limestone separate seams of asphalt, which limestone, though of the same nature as that containing the asphalt, is unimpregnated with bitumen. The contact of the two seams is clearly defined, and there is no exudation. Besides, the seams are never more impregnated in the middle than on the outside; rather the contrary.

Another hypothesis is based upon the often-demonstrated existence of bituminous springs under lakes. It has been supposed

that periods of deposition may have occurred under such conditions, that the molecules of limestone in suspension in the water have become mixed with the elements of bitumen; and that fortuitous circumstances caused the bitumen to fail. There would then be precipitated a white sediment, which would become impregnated on the return of the bituminous emanations: but when the repulsion which bitumen bears to damp substances is considered (simply wetting the fingers permits of its being touched without its adhering to them), there is little ground for belief in the existence of sufficient affinity between bitumen and limestone to support this theory.

Lastly, a Swiss geologist attributes the formation of asphalt to the presence of banks of the oyster called "Caprotine," capable of existing in deep seas. These animals, crushed by some convulsion of nature, afforded the bitumen said to be produced by all animal matter under certain conditions, as well as, in their shells, the limestone by which it was absorbed.

Extraction.

Bitumen is widely distributed in nature, but bituminous limestone is rare; indeed it has not been much sought after. The seams best known, which up to the present have supplied the demand for asphalt, are those of Seyssel and Val de Travers, both worked in the same manner on the surface, or in galleries, according to the position of the seams compared with the surface soil. Asphalt is quarried like limestone, with the advantage that the mine-holes can be made with an awl, and the stuff itself used for tamping.

Pulverisation.

Asphalt blocks must be pulverised before being used, and for this operation several processes have been tried.

1. Decrepitation, or breaking-up, takes advantage of the peculiar quality asphalt possesses of fusing, by the softening of the bitumen which holds together the limestone molecules. In the early stages of this process the asphalt was placed on heated iron plates called 'decrepitators'; but the stuff was spoiled by overheating, and by the bitumen being evaporated, so that the plan was abandoned.

2. At Seyssel, where the rock is harder, the decrepitators were replaced by crushing mills, which at an ordinary temperature produced a powder sifting well, but at a high temperature caused the rock to become sticky, and the mill to clog.

3. At the Val de Travers mines it was not possible to use crushing mills, or edge-runners revolving in a circular trough, on account of the nature of the rock; for they soon became covered with a layer of compressed asphalt, which had to be removed with a hammer and chisel.

4. With the extended use of asphalt all existing means for supplying the necessary quantity proved insufficient. Recourse was then had to plain rollers, which laminated the asphalt in thin sheets. The application of a little heat caused these sheets to fall to powder.

5. But the greatest improvement was the employment of Carr's disintegrator, first used by the Compagnie Générale des Asphaltes about 1867.

Asphalt reduced to powder admits of two distinct modes of application, viz., as compressed asphalt, which is obtained by heating the powder up to from 212° to 250° Fahrenheit, and causing the molecules to cohere under strong pressure; and as liquid asphalt, or asphaltic mastic, for which a manufacturing process is necessary. Then by heating the powder with an addition of from 5 to 8 per cent. of free bitumen, the latter causes the asphalt to melt, and gives a peculiar mastic which must be remelted before being employed. Although the introduction of compressed asphalt is of later date than asphaltic mastic, it will be described first, because the process is simpler, and is effected without the admixture of other matters.

II.—Compressed Asphalt.

The application of rock-asphalt to the construction of roads resulted from observing a fact of daily occurrence in asphalt mines. The detritus detached from the lumps of asphaltic rock, when crushed by the wheels of the carts employed on the works, forms on frequented roads a crust of superposed layers of compressed asphalt; but this effect is long in production, and only takes place in summer. In order to investigate this property of asphalt of reintegrating itself into blocks by compression, a series of experiments was undertaken, which proved that a certain degree of heat was required to render agglomeration easy. To effect this the apparatus for reducing the rock to powder was first employed, viz., the decrepitator, of boiler-plate slightly bowed out, placed above a fire-grate. The powder was spread over the plate, and frequently stirred. By this plan a careless workman might easily spoil a large portion of the material by overheating. Besides, the

powder when shovelled out lost heat rapidly. To mitigate these evils an apparatus analogous to a coffee-roaster was designed, viz., a closed cylinder slowly turning over a fire. The grate was movable, so that it might be replaced by a cart when the heating was complete. This apparatus, worked by suitable gearing, was fed at the axis end, and discharged the material by a trap in the circumference. Among the various attempts at preparing the powder, one was made of using steam. Blocks of asphalt inclosed in a cylinder were brought to the desired degree of heat by being subjected to a jet of steam from a portable engine. As soon as condensation ceased, the jet was turned off, the cylinder was emptied, and the blocks broken up. The powder thus produced was however spread with difficulty and irregularly; the rammers at times encountered parts thoroughly pulverised, at others refractory lumps requiring a much greater effort to make them into a level surface. Hence resulted inequality in the work; moreover, it was feared that the rock being impregnated by watery vapour might prevent the cohesion of the molecules.

The manner of spreading the powder over the soil previous to compression has varied considerably since works in asphalt became of importance. At first, when the rock was brought on to the ground like macadam, and decrepitated or comminuted on the spot, the small quantities of heated powder thus obtained necessitated the employment of rulers, which were placed across the street about 3 feet 3 inches to 5 feet apart, and limited the spreading or laying out of each batch. The powder within these boundaries was dressed down by hand with a wooden gauge. When, latterly, the heated powder was deposited from closed boxes with double sides, the guides were placed longitudinally in the street, so that it could be brought close to the work and used at once. These sections, spaced longitudinally at distances of 3 feet apart, required corresponding joints, which, although constituting a crucial test of the work, always stood well. At length it was found that asphalt cooled very slowly, and could be therefore allowed to remain for a considerable time in an open cart without inconvenience, and hence the use of gauges was abandoned; the workmen got into the habit of spreading the stuff with a rake to the required thickness completely across the street, and only made a joint where the work ceased for the day. To insure an equal thickness and regularity of the material, workmen skilled in the use of the rake were required. A mechanical rake, or spreader, which, whilst laying out the powder, would leave it at the proper thickness, is still a desideratum.

Compression by the Rammer.

Compression is effected either by rammers or by a roller. The employment of rammers had been impeded in the first instance by a tendency of the powder to adhere to the metal of which they were constructed and to agglomerate on it; their surfaces were planed without success; at last the difficulty was obviated by heating the rammers, when adherence ceased.

Steam Rammer.

The difficulty of relying upon even ramming, on account of the variation in the muscular efforts of the workmen, induced a persistent research for compression by mechanical means. Tolerable results were obtained as long as the work was done in narrow transverse strips, the compression being effected by a steam hammer moving on rails; but this ingenious system could not be applied to large works unless rails or rulers were laid beforehand.

The use of a roller was suggested by its constant employment in the construction of asphalt roads; but, besides the difficulty of draught, the powder was driven before it. Adhesion was prevented by covering the powder with a cloth, over which the roller was worked. As this system was not available for large surfaces, it was necessary to reduce considerably the weight of the roller, also to suspend to the axles a basket of live coal to prevent adherence and the displacement of the powder. The principal advantage of this plan was the regular compression obtainable without the employment of skilled labour. It would be well to complete the compression by means of a steam roller; the plan is simple, and will be necessitated by the extension of this kind of work. After ramming, and previous to the cooling down of the material, compression was generally equalised by a heavy roller. This operation was easy when rails were employed, as then the roller could not penetrate beyond a certain depth, but it became less so when the spreading of the material was continuous. Going too early on the still hot surface of the compressed powder with the heavy roller causes it to fly and tears it. Latterly, a roller composed of several sections placed on the same axle has been tried with success. When the surface containing an excess of heat mounts the narrow spaces between the different sections of the roller, just as it is displaced by the passage of a carriage, the surface is crossed and recrossed by the roller.

Compressed asphalt is the best roadway for bridges, on account

of its lightness, only a thickness of a few inches being required. With asphalt for a roadway there is no noise, no jarring of carriages, no street mud, and consequently no dust. Being impermeable, it does not absorb organic matters, the decomposition of which is so noxious to the public health of large towns; and in this respect it is better suited for narrow and damp streets than for wide thoroughfares, to which it has hitherto been specially devoted.

Early Applications of Compressed Asphalt.

In 1858, three sides of the Palais Royal, Paris, comprising an area of 3,000 square mètres (3,588 square yards), were laid with compressed asphalt. The material was brought to the site in the state of rock crushed into small pieces, and was heated and powdered by decrepitators; the concrete was 5·9 inches thick, the asphalt was 2·4 inches thick in the Rue St. Honoré and the Rue de Richelieu, and 2 inches in the Rue de Valois.

In order to overcome the hesitation of the city engineers, the company was obliged to propose a combination of payments by annuities, which were to include maintenance. The entire expense to the town of Paris was fixed at 20 francs per square mètre (say 13s. 3d. per square yard), payable by annuities of 4 francs during five years.

Success was complete in spite of an unpropitious season; and in the following year the engineers proposed that the Rue des Petits Champs should be paved in the same manner. This street had to be repaved for its entire length of more than 1,000 yards, on account of the construction of a large drain; but the circumstance was unfortunate. The street had been occupied by drainage works in the fine weather; and it was not until the month of October that the roadway could be begun, and then on a soil newly filled in to a depth of 10 to 13 feet. A bed of concrete only 4 inches thick was laid down, on which was superposed a layer of 2 inches of asphalt. The work was carried on during the months of November and December in rain and snow; and the street was opened for traffic on the 1st of January. Cracks immediately appeared, which completely checked the further extension of asphalt roadways. However, the experiment in the Palais Royal continued to give the best results; and as the same materials had been used, it became evident that the true causes of failure were the settling of the soil and the constant wet during the process of laying. Repairs were undertaken of each damaged

part in succession, and at the return of the fine weather all the evil had been remedied. The chief engineer in charge of the roadways declared this trial more satisfactory than the previous one, inasmuch as it proved that the material could be repaired extensively without stopping the traffic of the street. This work, which was carried out without any special conditions, was paid for at the rate of 15 francs the square mètre (say 10*s.* per square yard), including the concrete, estimated at 2 francs (1*s.* 7*d.*). This price was to serve as a basis for future proposals for repairing streets; and the examination of the plans by the engineers of the town of Paris was required by the Prefect. Despite the fact of the first experiment having been made on a loose subsoil, the company shortly afterwards received orders to repave on the same system the Rues Richer and Petites Ecuries, in which the construction of sewers had necessitated such deep cuttings that several foundations had settled, and the houses had to be rebuilt. Unusual precautions were taken to consolidate the soil. The disintegration of the asphalt had thus been much less than in the case of the Rue des Petits Champs; but repairs were more frequent than in other places where the foundation was solid.

Compressed asphalt, amongst other asphalts, was likewise laid down in the Rue Buffon, near the Museum of Natural History. In this case the asphalt rock was comminuted by means of steam.

About the year 1865, the engineers proposed to substitute compressed asphalt for granite sets to the extent of 100,000 square mètres (24·7 acres), to be executed in three years and paid for in five years. This work was begun in 1867, and was arrested in course of execution by the war of 1870. Here trials were first made with other rock than the Val de Travers, which had hitherto been exclusively used for compressed work. Seyssel rock was laid down on that part of the Rue de Richelieu comprised between the Boulevard and the Bourse, one of the busiest streets in Paris, and has answered perfectly. As in other roadways, the concrete was 4 inches thick and the asphalt 2 inches thick. The use of pure Seyssel rock was continued at the Place Louvois and the streets adjacent, with the same success.

Besides replacing granite sets, asphalt has been used to form crossings for foot passengers, in bands from 10 to 15 feet wide. Sometimes the asphalt is applied directly upon the hard macadam, sometimes upon prepared concrete. The crossings are paid for at the same rate as the larger surfaces, only an extra sum is allowed for repairs at the points of contact with the flints, where the wear and tear is much greater than that of ordinary asphalted roads.

In some places mixed roadways, composed of macadam in the middle and asphalt at each side, have been introduced. The point of contact with the rough stones is found to be perfectly supported by the asphalt edge, and the wheel traffic has no deleterious effect. This has been carried out in the Rue Royale, Boulevard de Sebastopol, Cours de Vincennes, and the Avenue de la Grande Armée, in Paris; and at Brussels the same system has been employed in the new boulevard of La Senne, only in the latter place granite pitching replaces macadam.

Compressed asphalt, moreover, has been successfully applied for courtyards and the interior of houses, where the thickness need not exceed 1¼ inch, as the duration appears to be unlimited. In Paris, the courtyards of the Grand Hôtel, the Hôtel de Louvre, the new Opera House, and of a large number of private establishments, amongst others, the Jockey Club and the Rue Scribe, are thus treated; and horses never stumble in such instances, for the asphalt is always kept clean.

The only objection that has ever been made against asphalt roads is that horses slip, and this reproach is only relative. In point of fact, asphalt is much less slippery than stone or granite, but its surface, being without joints, offers no resistance when a horse stumbles. How little slippery asphalt really is may be noticed after the washing effected by heavy rain. The fine dust deposited from the atmosphere, mixed with the staling of horses, gets spread over the surface by the street sweepers. It adheres closely to the asphalt as long as dry weather lasts, and cannot be removed by brooms. Essentially hygrometrical, it will absorb as much as ten times its volume of water. Therefore under the influence of the slightest humidity it begins to swell, and the thin pellicle is solved into a layer of greasy mud, which interposed between the horses' shoes and the asphalt, causes slipping. A simple precautionary measure is all that is needed, viz., to wash the asphalted surfaces every morning during wet or damp weather. The principal cause of slipping would thus disappear, and with it a good deal of prejudice against asphalt.

Wear and Tear.

The effect produced by wear and tear on asphalt is so trivial, that asphalt might almost be said to be imperishable, so long as no other cause than the friction of wheels occurs to alter its working conditions. On asphalted crossings in macadamised roads the wear and tear is rapid. In a few years the original thickness

285-120

of 2½ inches is reduced to 1½ inch, and finally to ½ inch; but in streets of ordinary circulation the annual wear and tear is inappreciable. This is evidently owing to the malleability of this body, which yields under a heavy load without being crushed.

Disintegration results most frequently from a singular phenomenon. After the asphalt has been laid and subjected to traffic for a short time, fissures appear on the surface, in places forming an endless network. Eventually the horses' hoofs remove small pieces, leaving holes. The reason of this is that parts perfectly good on the surface are fissured underneath, and that the fissures form nodules. No satisfactory explanation of this fact has been given. Greenish tints, found in fissures over earth blackened by gaseous emanations, have induced the belief that escaping coal gas was the cause; but chemical action would tend to pulverisation and not to nodulation; moreover, the effect is produced on parts free from such escapes of gas. This appearance is mostly noticed in work carried out during wet weather. When powder heated to 260° to 300° Fahr. is spread on a damp surface, steam is generated, which would permeate the whole if compression did not cause cohesion of the molecules on the surface, and force the watery vapour to localise itself, dividing the asphalt only to a height proportionate to the amount of humidity in the soil and the rapidity of the compression. The surface is always well compressed; and where the upper layer joins the nodulated part it is distended by the steam. This is the only cause of disintegration which can escape the eye of the engineer, and it can be avoided by care in laying.

The other causes which may be traced to deficient aggregation of the molecules are discovered either during the work or by the first vehicle which crosses the road. Deficient aggregation may arise from two circumstances; either the powder is too cold when employed, or it has been overheated. Overheating asphalt renders it as inert as sand. Another cause of deterioration, though rare, is the use of asphaltic rock too rich in bitumen. When this is the case, the compressed asphalt forms waves underneath the wheels of vehicles, sometimes longitudinal with the footways, at other times transversely thereto.

Maintenance.

The maintenance of asphalted roadways has engrossed the attention of engineers since asphalt has been substituted for granite. The advantages of asphalt as regards simplicity of application, cleanliness and facility of cleansing, pleasing ap-

pearance, and in many cases prime cost, are patent. Time and extended use alone can show whether this kind of road will last longer and be less costly than granite.

In Paris compressed asphalt had to compare with macadam and other systems of paving in stone, porphyry, granite, red sandstone, flags, cubes, &c. The advantage of less cost for repairs over macadam was incontestable. As regards paving stones, the difference was much less marked. A single estimate would scarcely suffice; but, the authorities of Paris alone possessing the data for making the calculation of the cost of maintenance of paving stones, it was necessary to proceed by induction. About twenty years ago the average maintenance of granite causeways was about 50 centimes the square mètre (4*d.* per square yard). The traffic having trebled, the needs of the public having increased, and the materials employed costing more, it was thought reasonable to ask double this price for a system offering so many advantages over paving stones; thus the Compagnie Général des Asphaltes contracted, in 1868, to keep roads in repair at the rate of 1 franc the mètre per annum (8*d.* per square yard), which price included an obligation to renew every year one-tenth[1] of the surface over five years old. This price was not arrived at by calculation alone; it was not possible that it should be, as the works already executed included the cost of experiments imperative with new works. Moreover, the large proportion of asphalted roadways being in streets where the traffic was heavy, did not admit of making a reliable comparison with the average cost of repairs of the roadways in the rest of the city, which included many streets with little traffic.

The Author is therefore of opinion that where the work can be carried out under favourable conditions, and where the majority of the streets are paved with this material, town councils need not pay 1 franc per mètre (8*d.* per square yard) for the maintenance and renewal of the roads. It is probable that for a large surface the average would be inconsidérable, and thus allow towns of secondary importance to procure for their inhabitants the advantages of roads paved with compressed asphalt.

Cost Price.

The value of the raw material is too great, and the cost of transport is too important, to enable a price to be quoted without specifying the locality where the material is to be employed; but

[1] Now one-fifteenth part.—Note of Translator

the quantity of raw material necessary for covering a given surface can be given, and thus every engineer can ascertain the price by adding the cost of transport to that of purchase.

The specific weight of asphalt being 2·2 to 2·3, the theoretical weight of 1 cubic mètre will be 2,300 kilogrammes (3,874 lbs. av. per cubic yard), and that of 1 square mètre, 1 centimètre thick (0·394 inch), 23 kilogrammes (50·7 av. lbs.), which in practice may be considered 25 kilogrammes (55·1 lbs. av.). Works employing say ten men, most of them labourers, a 25 to 30-HP. engine, and fitted with the necessary apparatus to avoid useless labour, can receive, crush, pulverise, and heat, in a day of ten hours, 30 to 40 tons of asphalt. The coal required for heating may be about 2 tons. The carts should take one horse-load, so that not too much material may arrive at the work at one time. The time of transit may last an hour without inconvenience.

For laying down, supposing the concrete ready and the workmen only occupied with the asphalt, the work in full swing, the job extensive and regularly supplied with hot powder, the labour costs little; a gang of ten to twelve men can complete 50 square mètres (538 square feet) in an hour. But for small undertakings the price of labour rapidly increases in proportion, being largely absorbed, for instance, in the cost of making cuttings for gas and water works, and in filling up depressions of the soil.

As regards the relative value of the only two asphaltic rocks used at present in laying compressed asphalt roadways, the Val de Travers limestone has not so close a grain, is softer, and is more regularly impregnated with bitumen than the Seyssel rock; but no engineer could conscientiously say that the Val de Travers is better than the Seyssel asphalt. The former may be safer in the execution of a work not subjected to supervision; the latter offers greater guarantees of good execution, because more care is required in the work.

III.—Asphalt Mastic.

It was under the form of mastic, designated by D'Eyrinys as "natural cement," that asphalt was first employed in public works in modern times. The slowness with which this material has made its way in the construction of houses can only be attributed to the mode of its employment necessitating heavy plant, and skilled workmen, who require a long apprenticeship.

Mastic asphalt has all the qualities of cement for uniting building materials, but the Author confines his attention to its application in making footpaths.

It has been already stated that bituminous limestone heated to between 212° and 300° Fahr. loses its consistency and is reduced to powder. If the heating be increased the powder does not melt, but the bitumen is evaporated, leaving the limestone, when at red heat, perfectly pure. If, however, on attaining a temperature of between 390° and 480°, a small portion of free bitumen be added the asphalt melts. This property leads to a complete transformation of the bituminous limestone; after melting it is no longer possible to reconstitute the asphalt and bitumen. Analysis gives bitumen and white limestone, but not bituminous limestone or asphalt. Moreover, of two pieces of asphalt rock, one containing 5 to 6 per cent. of bitumen, the other 15 per cent. of bitumen, the latter will not melt alone, whereas it will suffice to add from 7 to 8 per cent. of pure bitumen to the former to induce fusion and make a mastic, though less rich in bitumen than the first; but it will not remelt without a fresh addition of bitumen. It would thus appear that pure bitumen acts as a flux.

Bitumen.

Bitumen is widely disseminated, occurring in the products of decomposition of all organisms. That first employed for pharmaceutical purposes was evidently extracted from the asphalt itself. There existed an affinity between the two elements of fusion, and the mastic obtained would be of superior quality, but the process must have been very costly, on account of its necessitating distillation and of its wasting a large quantity of bituminous limestone. At Seyssel, for a long period bitumen was employed, produced from the bituminous sand of the soft greenstone which crops up frequently on the banks of the Rhone. Later a very rich seam of this stone was discovered at Bastennes in France.

The process employed for separating the bitumen from the sand is still the same as that described a century ago by D'Alembert in his Encyclopedia. The bituminous sand is poured into a boiler containing boiling water; at this temperature the bitumen becomes liquid and separates from the sand; being lighter than water, it rises to the surface, whereas the sand sinks to the bottom. This primitive mode answers perfectly so long as the rich sand is found at the surface and near roadways, but it becomes too expensive if the sand has to be carted to a distance.

Repeated attempts have been made to utilise the quality possessed by sulphuret of carbon of dissolving bitumen. An establishment was erected in Auvergne, where a great deal of sand rich

in bitumen was found. At Naples more extensive experiments were made with an apparatus which treated at the same time sulphur ore; but the results, though interesting, were too expensive to admit of the establishment of works. They showed, however, the expediency of continuing trials in this direction. The great drawback is the high price of sulphuret of carbon, combined with its great volatility, which causes loss from leakage.

For a long time Seyssel mastic was made with pure bitumen extracted from the soft stone, and for remelting the mastic when laying the footpaths Bastennes bitumen was obtained by the washing process as long as the seam lasted.

The chief quality required for bitumen used for footpaths is the retention of the pasty appearance under the influence of great variation of temperatures.

Indigenous Bitumens.

At first indigenous bitumens were tried, but the supply from Judæa was limited, and the price too high. Here it may be said that gas-tar is decidedly the worst form of bitumen for paving purposes, as it passes from the dry to the liquid state, and *vice versâ*, according to the season, and is very brittle.

Trinidad Bitumen.

Indigenous bitumens being found also in the state of dry pitch mixed with earth and water, efforts have been made to utilise those found on Lake Brea in the Island of Trinidad.

The spring of indigenous bitumen must have been considerable, for the water has almost disappeared from the lake, the bitumen forming a mass traversed only by a few narrow channels. The bitumen constantly springing up has overflown the banks, and, following the fall of the earth, has spread out seaward, forming a regular jetty, protecting vessels during their lading. Under the ardent sun of these latitudes the viscid matter partially evaporated, partially mixed with dust, has become solid on the surface, and forms the raw dry pitch exported to Europe. The process of removing 25 per cent. of foreign matter is effected by pouring into open boilers, which should not be exposed to naked flame, a given quantity of shale oil; as the oil gets heated, raw bitumen to about double the weight of the shale oil is added. The cooking with a steady fire lasts about eighteen to twenty hours. After sundry strainings and decantings, the purified bitumen is cooled and put into casks. This bitumen serves to replace that extracted

from the soft stone and sand when the operation is properly conducted, and the pitch is of good quality, but it also costs much less. The process of preparation is a delicate one, and the despatch in casks allows of fraud.

Manufacture of Mastic.

M. Malo, in his treatise, gives full explanations concerning the manufacture of mastic, which will not be further referred to. The material is sent to the places of consumption in blocks or cheeses 1 foot in diameter and about 4 inches thick. Like rock asphalt, heated alone, mastic does not melt, but only becomes soft; if the heating is continued it loses its bitumen and leaves a coal-like residuum. To endure remelting a fresh quantity of pure bitumen must be added.

Although it is only intended to refer to asphalt mastic in its relation to footpaths, it may be permitted to mention its application, under similar conditions, as a covering for vaults, its elasticity and malleability guaranteeing it against the cracks and fissures so often complained of in cement and mortar coverings.

The employment of asphalt mastic for footpaths is considerable. It is probable that, by illicitly using it as mortar, the idea arose of mixing sand with it. The result has proved excellent. No chemical union takes place between the mastic and the sand, but the cohesion is so complete that the fracture of sanded mastic will show the simultaneous fracture of the grit. Moreover, the non-susceptibility of sand to the heat of the sun compensates for the susceptibility of the mastic; and, as the quantity of grit or sand may reach 60 per cent., the price of the work can be proportionately reduced. The conditions necessary for the laying of mastic are to prepare it with the least possible quantity of bitumen, and to lay it as hot as practicable.

Laying Down.

For many years the apparatus for remelting the mastic consisted of boilers of a primitive construction of wrought iron, fitted with stove chimneys: but the use of these boilers in the streets was too inconvenient in such important works as those of the city of Paris. It became therefore necessary to contrive other means, and in 1858 the mastic was prepared in large stationary boilers in depôts, and delivered hot to the works in portable boilers, which could be heated and stirred during transport. The fixed boilers for preparing the sanded mastic are similar to those used for ordinary mastic, except that they are provided with a bell-shaped

mouthpiece to allow of the hot material being poured into the portable furnaces. The layer of mastic possessing no resistance in itself, and being simply a carpet, necessitates the consolidation of the soil, which is ordinarily done by concrete, the surface of which is floated with mortar.

Price of Work.

As with compressed asphalt, it is difficult to fix a price without knowing the locality of the work to be executed, on account of the cost of transport. The cost can, however, be readily arrived at as follows:—The preparation of 1 ton of sanded mastic requires 13 cwt. of pure block mastic, 2 qrs. 12 lbs. of bitumen, 7 cwt. of grit or sand washed and dried, and 2 cwt. of coal. A workman can easily prepare 3 tons of material in a day of twelve hours.

The specific weight of mastic being about the same as that of asphalt and sand, the weight of 1 cubic mètre of sanded mastic will be, say, 2 tons 6 cwt. (1 ton 15 cwt. per cubic yard), and consequently a layer 1 centimètre (0·39 inch) in thickness will give, theoretically, about 50 lbs. weight per square mètre, or, practically, 56 lbs. per square mètre (46 lbs per square yard).

It requires a long apprenticeship before the workman can obtain a layer of uniform thickness. A skilled workman can, when the surface is well prepared, and the hot mastic supplied continuously and well poured by his assistants, lay from 120 to 150 square mètres (140 to 180 square yards) in a day, 15 millimètres (0·6 inch) thick. As an average, 120 square mètres can be obtained by a gang of three men, *i.e.*, one spreader, and two bringers. When, on the other hand, the workman is obliged to prepare the mastic in the old pot boilers himself, he requires an assistant for each boiler, and the preparation takes four to five hours, without counting the laying and pouring. Under such conditions, a gang of three men will only lay 55 square mètres (66 square yards) a day.

The thickness generally used for footpaths and public buildings is 15 millimètres, equal to 35 to 38 kilogrammes of sanded mastic per square mètre (64 lbs. to 71 lbs. per square yard) For railway stations, where there is goods traffic, 2-centimètres thickness of mastic, or 45 kilogrammes per mètre (83 lbs. per square yard), is generally adopted; and for passages and entrances subject to heavy carriage traffic about 4 to 5 centimètres (1·6 inch to 2 inches) thickness is used.

Roadways or Causeways.

In Lyons mastic has been applied to several roadways, chiefly in the small, narrow, damp streets and alleys, for sanitary reasons;

and as the traffic is trifling, the repairs have been few. Some of these roadways are twenty years old.

The trials in Paris have given much less satisfactory results. The failure may perhaps be attributed to the mixture of two bodies—asphalt and grit, the resisting powers of which are essentially different. When, owing to the wear of the mastic, the grit appears on the surface of the roadway, it is soon displaced, leaving the socket exposed. This is a cause of disintegration, which, often repeated, soon leads to the breaking up of the roadway, and the drier the mastic, the quicker the destructive action. For roadways mastic asphalt has been generally abandoned in favour of compressed asphalt rock, which is homogeneous in texture.

Duration.

The duration of asphalt beds has, unfortunately, never been stated with sufficient accuracy, taking into account the modifications caused in laying gas and water pipes; but it is certain that asphalt mastic on footpaths will bear for a long time a considerable traffic of passengers.

In Paris, under the arcades of the Rue de Rivoli, of a mastic sidewalk laid in 1845, and which was not relaid until 1868, there remained a thickness of 3 to 4 millimètres (0·12 inch to 0·16 inch), which was removed in large sheets. Again, in the Place des Célestins, at Lyons, asphalt mastic laid in 1840 still exists in spite of heavy traffic.

In ordinary conditions, a duration of fifteen years may be reckoned upon. This basis has been adopted for a system of maintenance for more than twenty years in Paris for the footpaths. Against an annual payment of a fixed sum per mètre, the contractor undertakes the repair of the paths, and renews every year one-fifteenth part of the existing surface. Thus the normal thickness of the layers of mastic is always maintained.

Imitation Asphalt.

By analysis asphalt mastic gives limestone and bitumen. By mixing heated limestones and gas-tar, a material having some of the properties of asphalt mastic has been obtained, just as stucco has some of the properties of marble.

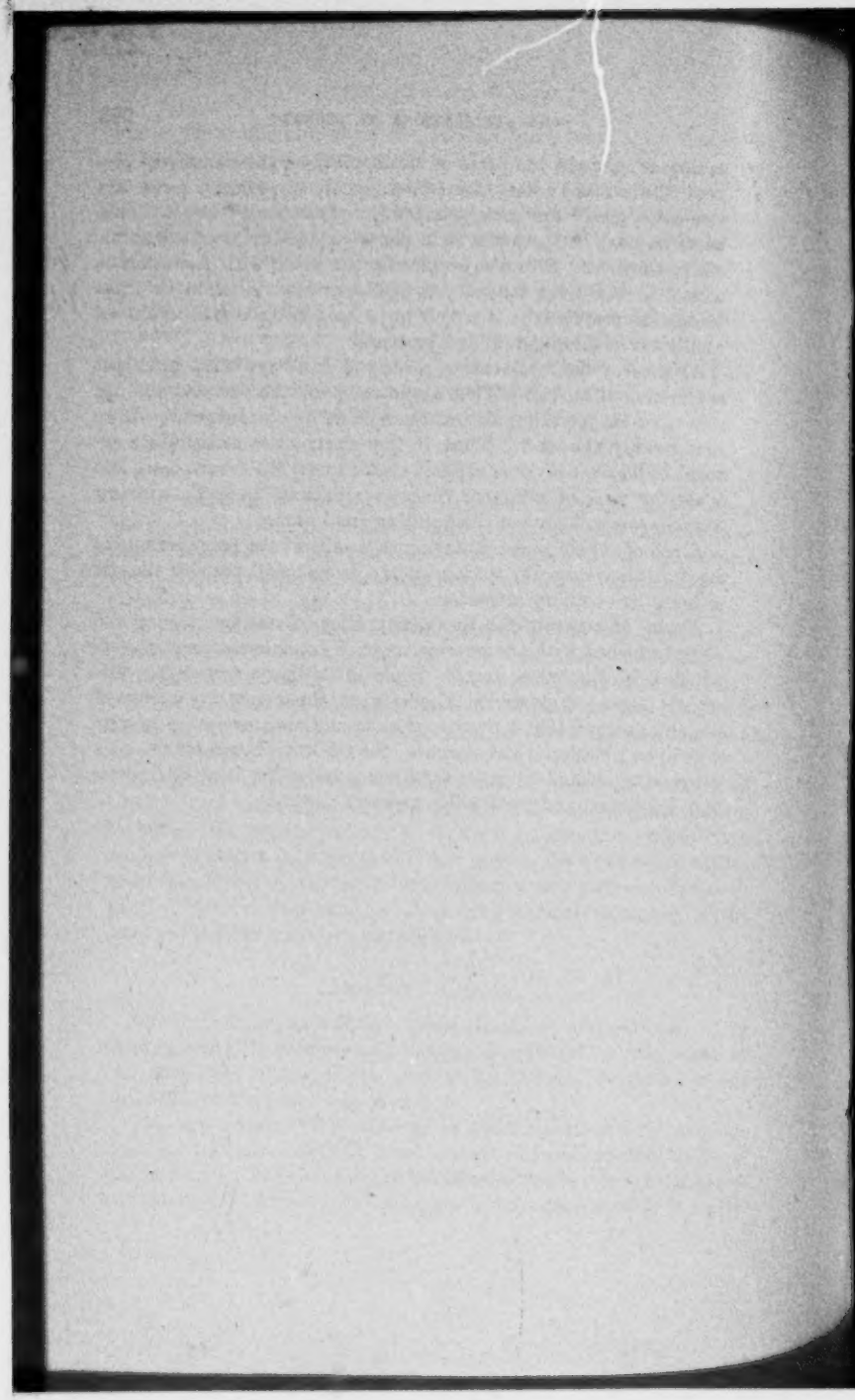
The first trustworthy trials gave a bad result, and the employment of imitation asphalt was proscribed in all specifications of public works: but as detection is difficult, frauds soon took place on a large scale. As the great economy in imitation asphalt is in the

saving of carriage, the proof of transport from the mines will prevent this in many cases. Imitation asphalt is applicable in certain rare cases, great care being taken in its preparation; but it should never be used for footpaths or in places exposed to great variations of temperature. Bitumen, artificially combined with limestone, is unable to resist the tendency to disintegration inherent in those bodies, the components of which have been subjected to unknown conditions of temperature and pressure.

At present the formation of roads and footways is the principal application of asphalt. When engineers know the material and can rely upon its special qualities, the field of its employment will be considerably extended. Thus, in the construction of buildings exposed to floods, a layer of asphalt mastic under the foundations, and a narrow wall of bitumous concrete all round up to the extreme water-level, will protect the building from damp.

A bed of rubble smeared well with mastic at the point where the masonry rises from the surface of the ground will prevent the rise of damp by capillary attraction.

Blocks of concrete for the construction of marine jetties and piers, furnished with an exterior layer of bituminous concrete 4 to 5 inches in thickness, may be made of ordinary materials. The asphalt mastic opposes its elasticity to the percussive action of the shingle, and its bitumen to the decomposing action of marine salts upon limestones and cements. Several such blocks, of 13 cubic yards, have existed for more than ten years at the Pont de Graves, near Bordeaux, and justify the Author's assertion.



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ANNALES
DES
PONTS ET CHAUSSEES.

MÉMOIRES ET DOCUMENTS
RELATIFS
A L'ART DES CONSTRUCTIONS
ET AU SERVICE DE L'INGÉNIEUR;
LOIS, DÉCRETS, ARRÊTÉS ET AUTRES ACTES
CONCERNANT
L'ADMINISTRATION DES PONTS ET CHAUSSÉES.

MÉMOIRES ET DOCUMENTS.

5e SÉRIE.
TOME XVIII.

1879

2me SEMESTRE.

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PARIS
DUNOD, ÉDITEUR,
LIBRAIRIE DES CORPS DES PONTS ET CHAUSSÉES ET DES MINES,
Quai des Augustins, n° 49.

affaire au constructeur de la chaussée de prendre ses mesures pour éviter la production de ces interstices.

Il arrive quelquefois cependant que les macarons se forment de haut en bas ; lorsque, par suite d'un tassement dans le sol ou d'une désorganisation du béton, l'asphalte gerce à la surface, l'humidité pénètre dans les fentes et produit les mêmes ravages que l'humidité sous-jacente. Mais ces détériorations sont peu fréquentes et toutes locales, elles se réparent facilement.

Réparations de l'asphalte comprimé. — En principe, rien n'est plus simple que ces réparations. Un trou s'étant formé dans la croûte asphaltique, on trace tout autour de ce trou une ligne qui embrasse tout le périmètre défectueux, on entaille l'asphalte suivant cette ligne jusqu'au béton, on enlève la partie malade que l'on remplace par de la poudre neuve, laquelle se pilonne de la même façon que dans le travail de premier établissement. Mais en pratique, cette opération présente de nombreuses difficultés et exige des soins assez minutieux.

D'abord, s'il s'agit de remplacer une portion détériorée par la présence de macarons (c'est le cas le plus ordinaire), on doit supprimer tout ce qui, dans le pourtour du défaut apparent, est plus ou moins avarié ; puis, comme le béton est toujours lui-même quelque peu atteint, on enlèvera de ce béton tout ce qui paraîtra avoir souffert ; on le nivellera par une application de ciment qu'on laissera bien prendre. Si le béton n'est pas compromis, mais seulement humide, on y coulera une couche de mastic d'asphalte qu'on enlèvera avant qu'elle se soit solidifiée. Le mastic liquide, qui est toujours à une température d'au moins 150° à 160°, évapore l'humidité et assèche rapidement la place. C'est alors seulement que l'on posera la poudre.

Dans les temps de pluie ou simplement d'humidité persistante, il est souvent impossible d'assécher complétement l'assiette de béton. Dans ce cas, il est d'usage de remplacer

provisoirement la partie de comprimé avariée par une couche de coulé d'égale épaisseur. Cette pièce de raccord demeure jusqu'à ce que le retour du beau temps permette de lui substituer la réparation définitive. Ce procédé est souvent insuffisant, surtout dans les rues très-fatiguées où la pièce en asphalte coulé est rapidement broyée par les roues. On préfère le procédé plus sûr qui consiste à couler sur le béton humide une mince couche de mastic et à achever la réparation en asphalte comprimé qui, posé sur cet enduit hydrofuge, tient ordinairement comme lorsqu'il l'est dans les conditions normales.

On ne doit jamais entailler l'asphalte à réparer suivant des lignes courbes, mais suivant des directions rectilignes; la soudure de la couche neuve avec l'ancienne se fait ainsi plus sûrement; les joints curvilignes tiennent rarement plus d'un an ou deux. On évitera également de diriger les lignes droites exactement dans le sens longitudinal de la chaussée, car alors les roues des voitures tendent à faire ouvrir les joints. Enfin il est essentiel de ne raccorder les surfaces neuves qu'avec des parties anciennes parfaitement saines et absolument exemptes de macarons.

La construction des chaussées en asphalte est difficile par le mauvais temps, cela est incontestable; la réparation des flaches, trous et autres défauts l'est plus encore. Cependant, à moins que les détériorations, par leur importance et leur fréquence, prennent le caractère d'un désastre, comme nous l'avons vu à Paris l'hiver dernier, il est toujours aisé de s'installer, soit pour la construction, soit pour les réparations, de façon à tenir les travaux à couvert. Nous ne saurions trop le répéter, le mortel ennemi de l'asphalte comprimé, c'est l'humidité sous-jacente; aussi la première prescription à imposer à un entrepreneur chargé de semblables travaux, nous pourrions dire la seule (la question de provenance de son minerai, bien entendu, réservée), c'est de ne jamais poser sa poudre que sur du béton

sec. On devrait donc toujours l'obliger à tenir ses travaux à l'abri de la pluie et à assécher son béton par des moyens artificiels lorsque ce béton a été mouillé. Assurément c'est l'intérêt de l'entrepreneur d'en agir ainsi, surtout lorsque, comme cela devrait toujours avoir lieu, il est assujetti à une garantie à long terme; mais tels sont les embarras, que des détériorations multipliées causent à la voirie d'une grande ville, lorsqu'ils prennent certaines proportions, que des mesures préventives prises en vue de les éviter ne sont jamais superflues et, nous le répétons, ces détériorations sont évitables.

Ce que nous avons dit de la réparation des détériorations accidentelles s'applique également aux tranchées de gaz ou d'eau. Seulement dans ce cas on est tenu à plus de précautions encore, car il faut remblayer la tranchée, pilonner le remblai, poser un nouveau béton, attendre que ce béton soit sec, et enfin placer la couche asphaltique comme on met une pièce à une étoffe. Ce genre de réparation est extrêmement délicat, en ce sens que si toutes les précautions nécessaires n'ont pas été prises pour obtenir un sous-sol parfaitement fixe; un tassement de quelques millimètres suffit pour produire à la surface une flache où l'eau séjourne.

Ces flaches sont d'ailleurs fréquentes dans les chaussées en asphalte et on le comprend aisément; il y a tant de causes qui peuvent altérer la parfaite régularité du profil, la couche asphaltique épousant rigoureusement toutes les ondulations de son assiette, que des cuvettes plus ou moins spacieuses, profondes de 1 à 10 ou 12 millimètres, se produisent très-souvent, où les eaux pluviales séjournent, au grand déplaisir des passants. Pendant longtemps on n'a eu d'autre moyen de les faire disparaître que de découper leur pourtour, d'enlever la croûte asphaltique et de la remplacer par de la poudre neuve, comme s'il s'agissait d'un trou compromettant toute l'épaisseur de la couche

d'asphalte. Nous avons indiqué récemment un remède plus rapide, beaucoup plus économique et qui, mis en pratique l'année dernière, a parfaitement réussi. Il consiste simplement à couvrir la flache d'une tôle chauffée, de 10 à 12 millimètres d'épaisseur, que l'on place à quelques centimètres de hauteur au-dessus du sol ; au bout de quelques minutes, la chaleur de la tôle ramollit l'asphalte sur 1 ou 2 centimètres de profondeur. On racle alors la surface pour en enlever la poussière et mettre à nu l'asphalte pur ; puis on saupoudre de poudre neuve et chaude en quantité suffisante pour combler la dépression et l'on pilonne énergiquement. Les deux poudres se soudent parfaitement et ne se séparent plus. Des réparations de ce genre faites il y a un an, sur nos conseils, aux chaussées asphaltées de Lyon ont fait disparaître des flaches d'une manière complète ; on n'en a jamais revu les traces.

Un autre genre de détérioration à redouter lorsqu'on emploie de la poudre trop riche en bitume est la formation des bourrelets. Tout le monde a remarqué que pendant les fortes chaleurs certaines chaussées en asphalte comprimé se ramollissent, se gondolent, se plissent, et qu'en fin de compte il reste à leur surface des espèces de bourrelets de forme irrégulière, qui parfois même refluent sur les canivaux. Il y a quelques années, nous avons vu, à Marseille, dans la rue qui longe la préfecture, des bourrelets semblables s'appuyer sur la bordure et en dépasser le niveau. La production de ces accidents est favorisée par l'instabilité du sol, par une pulvérisation incomplète ou par un chauffage insuffisant de la poudre, par un étendage défectueux, enfin par un pilonnage trop peu énergique. Très-souvent les roues des voitures détruisent ces bourrelets, mais pour les laisser se reformer plus loin. Il n'y a d'autre remède que de relever l'asphalte, le pulvériser et le chauffer à nouveau pour l'amaigrir un peu, puis le remettre en place. Mais on évitera de tels embarras si

l'on a soin de n'employer à la construction des chaussées que des roches asphaltiques, dont la teneur en bitume ne dépasse pas 10 p. 100, et surtout qui ne contiennent pas de principes huileux mélangés à leur bitume, ou bien en mélangeant les minerais trop riches avec des minerais plus pauvres, mais *provenant des mêmes gisements*. Il a été établi par des expériences nombreuses, que très-souvent des poudres provenant de gisements différents, ne supportent pas les mêmes températures pour être chauffées et comprimées. On pourrait probablement tourner la difficulté en chauffant chaque poudre séparément à la température qui lui convient et en les mélangeant ensuite ; mais c'est une complication à éviter autant que possible.

Trottoirs en asphalte comprimé. — Il y a une quinzaine d'années un essai de trottoir en asphalte comprimé fut tenté dans la grande halle du chemin de fer du Nord. C'était une hardiesse. L'asphalte comprimé qui n'obtient le complément de sa compression que par le roulage des voitures, ne paraissant pas indiqué pour résister à une fatigue de frottement et d'usure comme la subissent des trottoirs. Le trottoir de la gare du Nord avait 0,03 d'épaisseur ; il était soumis à un roulage fréquent des chariots à bagage, c'était en quelque sorte une fatigue mixte ; il tint parfaitement. Depuis, une grande quantité de trottoirs de ce genre ont été construits dans les rues de Paris, de Lyon, etc., et ont donné les meilleurs résultats. Le trottoir en asphalte comprimé est plus doux au pied et plus agréable à l'œil que celui en asphalte coulé ; nous le croyons plus cher ; c'est un trottoir de luxe et par là même désigné pour les quartiers opulents des capitales.

Pavés en asphalte comprimé. — L'outillage de construction et de réparation des chaussées en asphalte est compliqué, dispendieux, d'un transport difficile, il doit être manœuvré par des ouvriers spéciaux ; en sorte que, hors des villes de quelque importance l'usage du système pré-

Memoirs and Documents Relating to the Art of Building and to the Duty of the Engineer; Laws, Decrees, Orders and Other Acts Concerning Bridge and Road Administration.

MEMOIRES AND DOCUMENTS:

5th series, Vol. XVIII, 1879, 2nd semester. Paris, Dunod publisher, library of the Bridge, Road and Mine Corps No. 49 Augustine Quay.

(pp. 267-322) "Present State of the Asphalt Industry," by Leon Malo, C. E.

Translation (Page 298). *Repairs of compressed Asphalt.* In principle, nothing can be more simple than these repairs. A hole having formed itself in the asphaltic crust, all around said hole a line is traced which embraces the entire defective perimeter, following such line the asphalt is cut down as far as the beton (i. e., concrete) the bad part is lifted out and is replaced with new powder, which is tamped (i. e., pugged) in the same fashion as in the work of primary installation. But in practice this operation
309 presents numerous difficulties and exacts some quite minute cares.

First, if the point is to replace a portion deteriorated by the presence of "macaroons" (this is the most ordinary case) it is necessary to extirpate—within the limits of the visible defect—all that which is more or less damaged; then, since the beton itself is always a little bit affected the workman should take from the beton all that which seems to have been injured. He levels the beton by an application of cement which he should leave to set well. If the beton is not involved, but is merely humid, the operator flows a coat of asphalt mastic thereon which is taken out after it becomes solidified. The liquid mastic which is always at a temperature of 150 degrees—160 degrees at least, vaporizes the humidity and rapidly dries the place. It is only then that the powder should be laid.

In times of rain or simply of persistent dampness, it is frequently impossible to completely dry the beton site. In such case the usage is to replace, provisionally, the damaged part of the compressed by a layer of cast asphalt of equal depth. This

junction piece stays until the return of fair weather permits the definitive repair to be substituted for it. Such procedure is often insufficient especially in much used streets where the piece of cast asphalt is crushed rapidly by the wheels. The more certain practice is preferred that consists in flowing a slight layer of mastic over the humid beton and in finishing the repair with compressed asphalt which—set upon its water-proof layer—ordinarily holds as fast as it does when under normal conditions.

The asphalt to be repaired should never be cut following
310 along curved lines but (rather) following a rectilineal direction; the welding of the new layer with the old is thus made more sure; curve-line joints rarely hold more than a year or two. Equally, avoid guiding the straight lines exactly along the longitudinal course of the street since then, the wheels of the vehicles tend to open the joints. Finally, it is essentially to unite the new surfaces with none but old parts that are perfectly sound and absolutely exempt from "macaroons."

That the construction of asphalt roadways is difficult in bad weather, is incontestable; far more is the repair of flaws, holes and other defects. Still, unless the deteriorations—by their importance and frequency—assume the character of a disaster, as we have seen at Paris during the last winter, it is always easy, whether it be for construction or for repairs to install oneself in fashion to carry on the work under cover. We cannot too often repeat, the mortal enemy of compressed asphalt is subjacent moisture; therefore, the primary requirement to impose upon a contractor charged with such labors, we might say the sole (reserving, of course, the question of the production of his mineral) is to never place his powder upon other than dry beton. Hence he should be always obliged to conduct his work sheltered from the rain, and to dry his beton by artificial means when said beton has become wet. Assuredly, it is for the interest of the contractor to proceed thus, especially when—as should always happen, he is subject to a long term guaranty; but such are the embarrassments that multiple deteriorations cause to the traffic of a great city—when they assume certain proportions—that preventive measures taken with a view to avoid them are never superfluous and, we repeat, such deteriorations are avoidable.

311 What we have said about the repair of accidental defects applies equally to gas or water trenches. Only, in such case the operator needs besides to take further precautions because it is necessary to fill up the trench, tamp the filling, lay new

beton, see that the beton becomes dry and finally place the asphalt layer as he would set a piece to a fabric. This sort of repair is extremely delicate in the sense that if all the precautions necessary have not been taken to obtain a perfectly fixed sub-soil, a few millimeters settling suffices to produce at the surface, a hole where water collects.

For other reasons, these holes are frequent in asphalt roadways and it is easily understood; there are many causes which can alter the perfect regularity of the profile, the asphaltic layer embraces rigorously all the undulations of its bed so that slight basins (i. e., sunken spots) more or less spacious, of 1 to 10 to 12 millimeters depth are very often produced where the rain-water gathers to the great displeasure of the passers-by. For a long time there had been no other means to make these disappear than by cutting around their rim, lifting out the asphaltic crust and replacing it with new powder just as if a hole were in question comprising the whole depth of the layer of asphalt. We have recently pointed out a more rapid remedy, much more economical and which—put in practice the last year—has succeeded perfectly. It consists simply in covering the depression with a heated sheet metal plate, of 10 to 12 millimeters thickness, that is placed at a few centimeters height above the ground; at the end of a few minutes the heat of the plate softens the asphalt about 1 or 2 centimeters in depth. Then, the surface is raked to remove the dust therefrom and lay bare the pure asphalt; next, 312 new and warm powder is sprinkled over in quantity sufficient to fill up the depression and is tamped energetically. The two powders solder together perfectly and separate no more. Some repairs of this sort made a year ago under our counsel on the asphalt streets of Lyons have caused the depressions to disappear in a complete manner; traces thereof have never been seen again.

Another kind of deteriorations to dread when a powder is employed too rich in bitumen, is the formation of swellings. Everybody has remarked that during intense hot spells certain compressed asphalt streets soften, flow (*"se gondolent"*) fold, and in the end that there is left at their surfaces a species of swelling of irregular form which at times even flows over the gutter-ways. A few years ago we saw at Marseilles on the street which runs past the Prefect's residence, some like swellings resting against the curb and reaching beyond its level. The production of these mischances is favored by the instability of the soil; by an incom-

plete pulverization or insufficient heating of the powder, by a defective spreading finally by tamping with too-feeble energy. Very often the wheels of vehicles wear away these swellings but for them to amend takes too long. There is no other remedy than to lift off the asphalt, pulverize and heat it anew to reduce it a little before it is restored in place. But such embarrassments are eluded if care be taken to employ for the construction of streets none other than asphaltic rocks, the bitumen content of which does not exceed 10 per cent and above all which do not contain oily principals mixed with their bitumen or else by blending very rich minerals with minerals that are poorer but come *from the same deposit.* It has been established by numerous
313 experiences that very often powders coming from different depositories do not endure the same temperatures for heating and compression. Probably, the difficulty can be evaded by heating each powder separately to the temperature which suits it and mixing them afterwards; but this is a complication to be avoided as much as possible. (Page 302.)

1202

MINUTES OF PROCEEDINGS

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THE INSTITUTION

OF

CIVIL ENGINEERS;

WITH OTHER

SELECTED AND ABSTRACTED PAPERS.

VOL. LX.

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JAMES FORREST, ASSOC. INST. C.E., SECRETARY.

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Delano. Cowper also had referred to pitch and tar pavements; but pitch and tar were not asphalt. It was most important not to confound them in specifications, as their respective values and properties were widely different. Considerable areas of compressed asphalt had been laid in Berlin, Vienna, Pesth, Brussels, and New York, and he regretted that no engineer had described the mode of laying.

Correspondence.

Bixio. Mr. MAURICE BIXIO, President of the Paris General Cab Company, owning about twelve thousand horses and six thousand vehicles gave the results of his experience as to the most suitable material for roadways for vehicular traffic. The worst pavement was porphyry (grey Belgian granite sets, 4 inches by 6 inches). Falls of horses were much less frequent on asphalt, macadam, or rough pitching (sets of Fontainebleau gritstone 8 inches cube). For the horses, falls on asphalt were less dangerous than on any other material. Beyond all doubt traction was less on asphalt than on any other pavement. His company had made many experiments on this subject, from which he would quote, at random, the following, relating to the French four-wheeled cab, weighing 658 kilogrammes (1,447 lbs.):—

	Kilogrammes.	
Traction on rough pitching	16·37	(36 lbs.)
„ small sets	14·79	(32·5 lbs.)
	Min. Max.	
„ macadam	14·0 to 20·5	(30·8 to 45 lbs.)
„ compressed asphalt (Val de Travers)	12·79	(28 lbs.)

It was probable, though difficult to establish otherwise than by comparison, that the wear and tear of the different parts of a vehicle was less rapid on asphalt than on other pavements. But the comparison did not apply in its entirety to macadam, in which case the tires of the wheel and the horse-shoes were the only parts that wore out more rapidly than on asphalt. The difference of wear was due to the jolting produced by sets, which naturally induced friction between all parts susceptible to that action. He thought that, traction being less, fatigue to the horse would also be less; but that was only an opinion, and not based on actual experiment. Asphalt was excellent also for granaries and for lining wooden mangers. For the paving of stables his company had made few experiments with the material, but as far as they had gone they were well satisfied.

Chabrier Mr. ERNEST CHABRIER wished to deprecate a practice which had been tolerated for some time in the depôts of the city of Paris,

viz., the mixture of several kinds of asphalt, with a view to obtain an average quality which would be supposed capable of meeting general requirements. The principal quality to be sought for in rock asphalt for laying on roads was, the greatest possible homogeneity in the grain of the limestone, and equal regularity in the amount of the bituminous matrix. The greater this uniformity the longer would be the endurance of the asphalt roadway. He would illustrate this by referring to the fact, well known by all engineers concerned with roadmaking, that a mixture of hard with soft metal formed a less enduring surface than one of the softer material alone. The uniform wear of all parts maintained cohesion, which, on the contrary, was rapidly destroyed when a piece of hard stone was, from continual vibration, displaced, without being crushed, thereby leaving a hole. When asphalt rock was not suitable for road surfaces it was either too poor or too rich. In the first case the particles did not cohere; in the second the carriage wheels sank into the material. The practice had been allowed of mixing these two kinds of rock in proportions impossible to be accurately determined, the process being left to the rule of thumb of the workmen. It was only reasonable to suppose that the requisite care was not always bestowed, and in case of bad mixing bad work would result, and a much more rapid deterioration must be expected, on account of the non-homogeneity of the material. It was, therefore, most important that persons proposing to lay down asphalt roadways should, above all things, get the particular rock best suited to the purpose, and further, should seek to obtain it of as even texture as possible. Mr. Chabrier.

Mr. LAVALLARD, Director of the Stock and Forage Department of the Paris General Omnibus Company, gave some information relative to the traction of heavy vehicles on asphalt carriageways. The standard omnibus of the Paris Company weighed from 1·67 to 1·77 ton empty, and from 3 to 3·6 tons when full. The diameter of the fore-wheels was 4½ feet, of the hind wheels 5 feet, the width of the tires being 2½ inches. The new three-horse omnibus weighed, when full, from 5 to 5½ tons; the diameter of the fore wheels was 3¾ feet, and of the hind wheels 5 feet, the width of tires being 3½ to 3½ inches. The company's tramway omnibus[1] weighed, when full, 6 tons, and the diameter of the wheels was 3½ feet throughout. The result of daily experi- Mr. Lavallard.

[1] The vehicle used on the tramways of the Paris Omnibus Company is not a car as usually understood, but merely a big omnibus on flanged wheels. The tramway companies use cars of the same character as those in London.

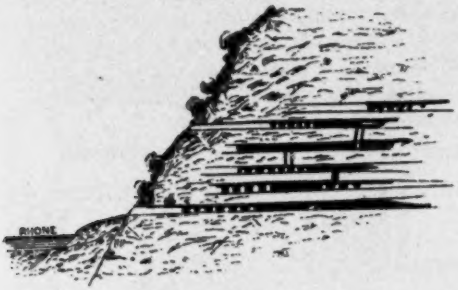
Mr. Lavallard. ence showed that when the weather was not very warm and the asphalt remained hard, traction on this material was less than on ordinary roadways; but that when the asphalt became softened, by the heat of a fierce sun, traction became considerable and augmented with the rise of the thermometer and the weight of the vehicle. When the asphalt was either dry or wet it afforded a good foothold for the horses. But when the asphalt was beginning to get wet or beginning to dry the horses had much difficulty in keeping up. Under such conditions the asphalt was slippery, and the fall of horses became frequent. This did not, however, affect the traction of the vehicles, which still remained less than on other roadways. The wear and tear of tires, axles, harness, &c., was less on asphalt because shocks were imperceptible. Although, under the conditions named, horses fell more frequently on asphalt than on granite sets, the injuries received were less serious. It, however, resolved itself into a question of shoes, and he thought the adoption of the Charlier horse-shoe had met the difficulty. His company found that asphalt succeeded perfectly as a flooring for granaries and forage stores, but not so well for stables, where it had in most cases to be abandoned, owing to the weight of the horses (from 10 to 12 cwt. each) causing depressions in the material when softened by the warmth of the recumbent animal. The urine collected in these holes, and, moreover, the asphalt was too smooth for the straw, which was always found kicked out behind the stall. Perhaps for horses of a lighter build the inconvenience would not be so great. Latterly they had had reason to believe that the consistence of the subsoil had some influence on the question, because they had stables wherein asphalt floors laid ten or twelve years ago were still in good condition. The cost of maintaining the asphalt laid along their tramways was 1 franc 20 centimes per square metre per annum.

Mr. Malo. Mr. L. MALO contributed some particulars of the mode of working the asphalt beds in the Seyssel mines, Pyrimont, France. The beds were cut in two by the river Rhone; the workings on the right bank being known as the Pyrimont mine, those on the left as the Volant mine. The layers of asphalt in the two mines were in all respects identical, and it was believed that they originally formed part of the same strata, through which geological action had made the chasm now filled by the Rhone. The beds of asphalt took the form of wide steps, never overlapping but at their extremities. Access to the rock was obtained by galleries (Fig. 4) cut in the hillside; but for the seven workings only two galleries were pierced, one at the highest, and the other at the lowest,

levels; the intermediate stages being reached by inclined planes. The asphalt was brought out at the lowest level. The mines were

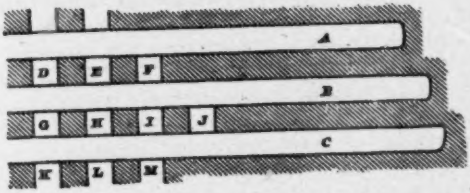
Mr. Male.

FIG. 4.



worked on the board and pillar system (Fig. 5), the pillars being about 3·5 mètres (11½ feet) on the side, which width also sufficed for the galleries. These dimensions were arbitrary, for sometimes the roof of the gallery was bad and the pillar got crushed, while in

FIG. 5.

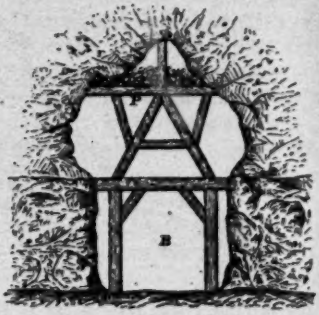


other cases it was good and the pillars had an excess of strength; but the mode of working exacted that the dimensions of the supports should be constant. Nevertheless, when there was reason to fear that the pillars were too weak, the material between several supports was not extracted. When the roof was of good sound rock, timbering was dispensed with; but otherwise it was necessary to support it by oaken baulks, as shown in Fig. 6. It occasionally happened that the roof of a gallery failed, and that the marl fell in such quantities as to form above the asphalt a vast cavity very dangerous to the miners; the least block falling from such a height sufficing to kill a man. In such cases elaborate timbering was resorted to, and a ceiling was laid (P, Fig. 7), on which were placed fascines to deaden the shock of falling rubbish. The rock was got by blasting with powder. Dynamite, and other

Mr. Malo. powerful explosives of a rending nature, had been tried, but had not given good results, on account of the relatively yielding

Fig. 6.

Fig. 7.



nature of asphalt. The beds varied in thickness between 1 mètre 50 centimètres and 4 mètres 50 centimètres (4·5 feet to 14·9 feet), but their extent was not ascertained. The mineral varied, in regard to its amount of bituminous impregnation, from 6½ to 9½ per cent., the poorest rock being as intimately saturated as the richest, although the quantity of bitumen was so much less. It was found that the more homogeneous the structure of an asphalt the more readily was its preparation (*cuisson*) effected; and, further, the more easily it took up the bitumen added to it in the boilers when destined to be made into mastic. Seyssel asphalt was used in two ways; pulverised, heated and rammed, for the well-known compressed asphalt roadways; as mastic, by the addition of a small quantity of free bitumen; in the latter case the material being moulded into cakes and destined to be re-melted for making footways, &c.

Seyssel rock possessed the valuable property of containing the exact proportion necessary for forming a layer of compressed asphalt, at once solid and, to a certain point, unaffected by the heat of the sun. But when not subject to deformation from softening, its manipulation was more delicate than that of other asphalts, and exacted a higher degree of skill in the workman. Mastic made from Seyssel asphalt likewise possessed great advantages, arising from the nature of the rock; but here again the best results were not obtained except by the employment of the purest natural bitumen, if possible similar to that impregnating the rock. Footways in Seyssel mastic, laid forty years

ago, still survived; and some years ago Mr. Malo had taken up, in one of the most frequented streets of Lyons—the Place des Celestins—a section of asphalt mastic twenty-five years old, which, though worn to a mere film 5 millimètres (0·19 inch) thick, was still intact, without holes, fissures, or depressions. In conclusion he would remark that the greater number of failures in asphalt works resulted from the contractors not seeing that the material came from well-known mines, or at least from sources vouched for by experts in this industry. Mr. Malo.

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LÉON MALO

L'ASPHALTE

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grandes villes. Nous verrons dans les pages suivantes quels avantages elle présente sur tous les autres systèmes connus, non pas seulement au point de vue de l'élégance, du confort et de l'hygiène publique, mais encore au point de vue du prix et de la durée. Nous indiquerons ensuite les usages encore peu connus auxquels l'asphalte comprimé peut se prêter.

Entretien des chaussées. — La chaussée terminée et livrée à la circulation il faut pourvoir à son entretien.

L'entretien se compose de deux sortes d'opérations : les réparations des parties détériorées accidentellement et celles des surfaces dégradées par certaines nécessités de service, comme par exemple les tranchées de gaz ou d'égout.

Dans beaucoup de grandes villes étrangères, (on commence à faire de même à Paris), on a maintenant la sage précaution de rejeter, autant que faire se peut, sous les trottoirs les égouts, les tuyaux de distribution d'eau et de gaz. On évite ainsi de fréquents rema-

niements de la chaussée, dont l'asphalte comprimé souffre naturellement plus que le pavé. A Paris où, dans beaucoup de rues asphaltées, ces canaux et tuyaux sont encore sous la chaussée il arrive souvent que l'on doit y pratiquer des tranchées à travers l'asphalte, le béton et le sous-sol.

Lorsqu'il s'agit de refermer cette tranchée, on est obligé, après le remblai du sol, de le tasser énergiquement afin qu'il ne se produise pas de dénivellation à la surface ; puis, le béton est reconstruit sur l'emplacement où il a été enlevé et l'asphalte posé sur le béton de la manière ordinaire.

L'opération est simple ; toutefois, deux précautions doivent être expressément recommandées pour éviter les détériorations ultérieures.

La première, c'est que, lorsqu'on enlève l'asphalte pour commencer le creusement de la tranchée, on ait soin de découper au ciseau la portion à détacher sans la soulever avec la pioche pour la casser. Ce soulèvement a pour effet de compromettre les parties qui doivent être conservées, en les fendillant par dessous, et cela suffit pour que de graves

désordres s'en suivent plus tard dans cette région de la croûte asphaltique.

La seconde précaution consiste à chauffer les bords de la couche asphaltée limitant le trou de la tranchée, avant de verser la poudre chaude destinée à refaire la partie manquante. Il importe que la soudure soit parfaite ; car, cette soudure se trouvant généralement en ligne droite dans la direction du mouvement des voitures, si l'adhérence de l'ancienne surface asphaltée avec la neuve n'était pas complète, la fente pourrait s'ouvrir et devenir le germe d'une détérioration.

L'entretien au point de vue des détériorations accidentelles est plus compliqué.

La croûte asphaltique peut dépérir accidentellement de deux façons ; par dessous ou par-dessus.

Les détériorations produites par la production de ce que l'usage a désigné sous le nom de *macarons* proviennent principalement, comme nous l'avons dit précédemment, de la vaporisation de l'humidité sous-jacente, ou bien de l'ascension de l'eau qui se trouve fortuitement emprisonnée entre l'asphalte et le béton et que la pression déterminée par le

roulage des voitures force à pénétrer dans la couche. Cette vapeur et cette eau découpent l'asphalte en menus fragments et, peu à peu, par des fissures verticales plus ou moins multipliées, viennent jusqu'à la surface ; les roues des voitures rencontrant ces parties désagrégées y creusent un trou qui, s'il n'est réparé promptement, finit par s'approfondir jusqu'au béton. Le seul remède à ce mal est d'enlever toute la partie malade et de la remplacer par de l'asphalte neuf, en ayant soin de chauffer les bords de la partie saine de façon à obtenir une soudure parfaite, comme nous l'avons expliqué un peu plus haut.

Nous devons dire qu'autrefois la production des *macarons* était singulièrement favorisée par la mauvaise qualité du béton qui, se désagrégeant sous l'action de la circulation, contribuait à désagréger l'asphalte lui-même. Aussi, ce genre de détérioration est-il devenu fort rare depuis que l'on ne pose plus l'asphalte comprimé que sur une assiette de béton de Portland inébranlable et sèche. Les défauts les plus fréquents aujourd'hui sont ceux qui prennent naissance à la surface

supérieure de la couche et se propagent de haut en bas.

Il est bien entendu que nous ne parlons ici que des chaussées construites convenablement, par des ouvriers expérimentés, avec des matériaux de choix ; les autres, comme celles dont Paris a été infesté de 1878 à 1884 et partiellement dans le courant de 1887, comportent d'autres accidents auxquels nul entretien ne peut remédier. Il n'entre pas dans le cadre de cette étude d'examiner les moyens d entretenir des ouvrages qui *a priori* doivent être proscrits de tout sérieux travail de voirie.

Les détériorations de la surface sont généralement de peu d'importance, si l'on a soin de les surveiller et d'y porter remède dès leur origine. Tantôt des creux se sont formés sous le passage des voitures lourdement chargées, ou qui ont séjourné trop longtemps sur l'asphalte très chauffé par le soleil d'été ; tantôt des matières étrangères, bois, fer ou pierre se sont trouvées emprisonnées dans la couche d'asphalte et y ont introduit un germe de destruction ; d'autres fois ce sont des eaux grasses ou ménagères qui, lancées d'une

façon trop suivie dans les caniveaux, dissolvent à la longue le bitume de l'asphalte et forment des lèpres qui, lentement, s'élargissent et se creusent. L'asphalte comprimé est une matière homogène et exclusive qui ne supporte la présence d'aucun corps étranger. Il faut que, plus ou moins promptement, ce corps soit expulsé en laissant à sa place un vide qui doit être comblé sous peine de devenir le point de départ d'une désagrégation plus ou moins importante.

Lorsque cette détérioration est assez profonde pour atteindre le béton, ou s'en approcher, il faut procéder comme nous l'avons expliqué plus haut : découper l'asphalte sur toute sa profondeur et remplir le trou ainsi formé avec de la poudre chaude que l'on pilonne dans les conditions ordinaires.

Si le défaut ne dépasse pas une profondeur de quelques millimètres, il est inutile de sacrifier toute l'épaisseur saine de la couche. Nous avons indiqué pour ce cas un procédé qui s'applique depuis quelques années avec un complet succès.

Dans un petit fourneau roulant on fait chauffer une plaque en fer de 10 à 12 m/m d'épaisseur que l'on pose sur la partie de chaussée à réparer. La chaleur de la tôle ramollit la couche asphaltique que l'on peut ensuite gratter et enlever à la profondeur nécessaire pour que tout germe de détérioration soit extirpé. Tandis que la plaie est encore chaude, on y répand une couche de poudre neuve que l'on pilonne jusqu'à ce qu'elle ait pris exactement le niveau de la chaussée. Au bout d'une demi-heure, on peut livrer l'emplacement à la circulation.

Ce mode de réparation est aussi très efficacement employé à la rectification des flâches qui souvent se trouvent à la surface de l'asphalte comprimé sans qu'elle ait cessé pour cela d'être saine. Ces flâches qui proviennent, la plupart du temps, d'une inégale répartition de la poudre au moment de la pose, peuvent être assez profondes pour former en temps de pluie des petits lacs longs à sécher et désagréables pour les piétons. On se borne à réchauffer au moyen de la tôle rouge dont nous avons parlé la surface flâcheuse pour la ramollir et la rendre propre

à la soudure ; on la gratte légèrement, puis on y répand la quantité de poudre chaude nécessaire pour qu'après pilonnage la dépression soit comblée. La soudure alors est parfaite et la flâche a disparu.

L'entretien est en général un service compliqué, en ce que le travail à faire est indéfiniment fractionné et dispersé sur des points nombreux ; une entreprise bien ordonnée doit s'appliquer à organiser des ateliers de réparation ambulants comportant tout l'outillage et tout le personnel nécessaires afin d'exécuter le plus rapidement possible. Ce service doit se faire la nuit, après qu'un examen de jour aura nettement déterminé la nature des détériorations à réparer, leur importance et le genre d'outils à y employer.

3° AVANTAGES DES CHAUSSÉES EN ASPHALTE COMPRIMÉ

Si les vicissitudes imméritées qu'a traversées ce système et dont nous avons précédemment parlé, n'étaient venues jeter sur

LEON MALO " ASPHALT: ITS ORIGIN, ITS PREPARATIONS AND ITS APPLICATIONS".

2ND EDITION, ENTIRELY REMODELED AND PUT ABREAST OF THE LATEST IMPROVEMENTS IN THE ASPHALT INDUSTRY.

Paris, Polytechnic Book-store, Baudry & Co., Publishers, 15 Rue des Saintes-Peres; Liege Branch 19 Rue Lambert-Lebegue. 1888, Rights Reserved.

" APPLICATIONS OF ASPHALT."

Translation (p. 108). *Maintenance of streets.*—The street finished and open to circulation it is necessary to see to its keeping.

Maintenance is composed of two sorts of operations: The repairs of parts deteriorated accidentally and the repairs of surface damaged through certain necessities of service, as, for example, the trenches for gas or sewerage.

In many of the large foreign cities (we commence to do the same in Paris) there is established the wise precaution of throwing back, so far as can be done, beneath the sidewalks, the sewers and the distribution pipes for water and gas. Thus is avoided the frequent repairs

of the roadway from which compressed asphalt suffers naturally, more than paving blocks. In Paris, where, on many of the asphalt streets these drains and pipes are still beneath the roadway it often happens that it is necessary there to make the trenches traverse the asphalt, the beton and the sub-soil.

When the business is too close such a trench, it is obligatory—after banking the earth—to ram it energetically in order that it may not cause any unevenness at the surface; then, the beton is rebuilt upon the site from whence it has been taken and the asphalt set upon the beton in the ordinary manner.

The operation is simple, nevertheless two precautions must be expressly recommended to avoid ulterior deteriorations.

The first is that when the asphalt is lifted off to commence the digging of the trench, the workman should be careful to cut out by chisel the portion to be detached without heaving it up with the pick to shatter it. Such upheaval has for its effect to injure parts which ought to be conserved—parts crack off beneath—and that suffices to cause grave disorders thence to follow later on in such region of the asphaltic crust.

The second precaution consists in heating the edge rims of the asphalted bed which limit (*i. e.*, define) the hole of the trench before pouring in the hot powder destined to repair the part lacking. It is important that the soldering should be perfect, because such soldering is generally to be met with in right line along the direction of movement of the vehicles if the adherence of the old asphalted surface with the new be not complete, the vent may open and become the germ (*i. e.*, source) of a deterioration.

Maintenance from the point of view of chance deteriorations is more complicated.

The asphaltic crust can decay accidentally in two fashions, from below or from above.

Deteriorations caused through the production of that which usage has designated by the name "*macaroons*" spring principally, as we have said before, from the vaporization of the subsequent moisture or else from the ascension of water found casually imprisoned between the asphalt and beton and which the determined pressure from the rolling of vehicles forces to penetrate into the layer. This vapor and this water cut up the asphalt into minute fragments, and little by little, through vertical fissures more or less multiplied, arrive at the surface. The wheels of vehicles encounter the disintegrated parts, digging there a hole which—if it be not promptly repaired—finishes by deepening itself as far as the beton. The sole remedy for this evil is to remove all the bad part and replace it by new asphalt, taking care therein to heat the edges of the sound portion so as to obtain a perfect soldering, as we have explained a little further back.

We should say that formerly the production of "macaroons" was singularly favored by the bad quality of the beton which—disintegrating under the action of the traffic—contributed to the disintegration of the asphalt itself. However, this sort of deterioration has become very rare since the operator no longer sets the compressed asphalt except upon a bed of Portland concrete—fixed and dry. The most frequent defects to-day are those which take birth at the upper surface of the layer and spread beneath from above.

It is of course understood that we speak here of none except streets properly constructed by experienced workmen with selected materials. The others, like those with which Paris was infested from 1878 to 1884 and partially during the course of 1887 allow of other accidents against which no maintenance can work remedy. It does not come within the limits of this study to examine means for the maintenance of works which *a priori* ought to be proscribed from all serious regard of the street commission.

Deteriorations at the surface are generally of little importance if care be taken to look after them and apply remedy thereto from their beginning. Sometimes holes are formed under passage of wagons heavily loaded or which have staid too long upon the asphalt highly heated by the summer sun, sometimes foreign materials—wood, iron, or stone happen to be imprisoned in the bed of asphalt and have introduced there a source (germ) of destruction; at other times it is greasy or kitchen waters which—thrown in very regular fashion into the gutters—dissolve at length the bitumen of the asphalt and form a leprosy which slowly enlarges and burrows. Compressed asphalt is an homogenous and exclusive material which will not support the presence of any foreign body. It must be that—more or less promptly—such body becomes expelled leaving a void in its place which needs to be filled up under penalty of becoming the point of departure for a more or less important disintegration.

When such deterioration is sufficiently deep to attain unto the beton or to approach it, it is necessary to proceed as we have explained above: cut out the asphalt through its total depth and re-fill the hole thus formed

with hot powder which the workman tamps under the ordinary conditions.

If the defect does not extend beyond a depth of a few millimeters it is useless to sacrifice the whole sound thickness of the layer. For such case we have pointed out a process which has been applied now for several years with complete success.

In a small rolling furnace, an iron plate of 10 to 12mm. thickness is heated which is placed over the part of the street to be repaired. The heat of the plate softens the asphaltic layer which can thereupon be scraped and removed to the depth necessary in order that every source (germ) of deterioration shall be extirpated. While the wound is still hot there is spread thereon a layer of fresh (new) powder which is tamped down until it has taken exactly the level of the street. At the end of an half hour, the operator can throw the piece (site) open to circulation.

This mode of repair is also employed very efficaciously for the rectification of sunken spots often found at the surface of compressed asphalt without the latter ceasing to be sound because of them. These spots which are due, for the greater part of the time, to an unequal distribution of the powder at the moment of laying, can be sufficiently deep to form in rainy weather small lakes, slow to dry and disagreeable for pedestrians. It is simply requisite to reheat by means of the red-hot plate of which we have spoken, the depressed surface in order to soften and render it proper for soldering (welding). The spot is raked lightly, next there is spread over it the necessary quantity of hot powder so that after tamping the depression may be filled up. The solder-

ing is then perfected and the sunken spot has disappeared.

Maintenance is in general a complicated service in which the work to be done is indefinitely divided and dispersed over numerous points; a well ordered establishment ought to apply itself to the organization of ambulatory repair shops admitting of all the implements and all the persons necessary to execute the object (end) in view with the utmost rapidity possible. Such service should be done at night after an examination by day has plainly determined the nature of the deteriorations to be repaired, their importance and the sort of tools to be there employed. (page 115.)

341 THE UNITED STATES OF AMERICA, SS.

The President of the United States, to the Judges of the Circuit Court of the United States for the Northern District of Illinois, Northern Division. Greeting:

Whereas in a certain suit in said United States Circuit Court for the Northern District of Illinois, Northern Division, between the United States Repair and Guaranty Company, complainants, and Assyrian Asphalt Company and James P. Mallette, defendants, which suit was removed to the United States Circuit Court of Appeals for the Seventh Circuit, by virtue of an appeal agreeably to the Act of Congress in such case made and provided, a diminution of the record and proceedings of said cause has been suggested, to-wit: That Complainants' rebuttal evidence in said cause No. 24,534, of record in the said United States Circuit Court for the Northern District of Illinois, Northern Division, is omitted from the transcript.

You therefore, are hereby commanded that, searching the record and proceedings in said cause, you certify that omissions to the extent above enumerated, you shall find to the said United States Circuit Court of Appeals for the Seventh Circuit, so that you have the same together with this writ before the said United States Circuit Court of Appeals for the Seventh Circuit forthwith.

Witness the Honorable Melville W. Fuller, Chief Justice of the United States, this 12th day of October, A. D. 1899.

EDWARD M. HOLLOWAY,
Clerk United States Circuit Court of Appeals
for the Seventh Circuit.

(Seal.)

To the Honorable Judges of the United States Circuit Court of Appeals for the Seventh Circuit, Greeting:

In obedience to the Writ of Certiorari to me directed, I do hereby make return thereto by transmitting the rebuttal evidence of the complainant in Case Number 24,534, in which the United States Repair and Guaranty Company is complainant and Assyrian Asphalt Company and James P. Mallette are defendants, duly certified under my hand and the seal of said Court, this 13th dav of October, 1899.

S. W. BURNHAM,
Clerk.

(Seal.)

342 United States Repair and Guaranty Company,
Complainant,
vs.
Assyrian Asphalt Company and James P. Mallette,
Defendants.
} 24534.

It is hereby stipulated and agreed by and between the parties to the above entitled cause that the clerk in making return to the Writ of Certiorari, issued herein from the United States Circuit Court of Appeals for the Seventh Circuit, may use a printed copy of the Complainant's Rebuttal Testimony and all errors therein are hereby expressly waived.

RAYMOND & OMOHUNDRO,
Solicitors for Complainant.
PEIRCE & FISHER,
Solicitors for Defendants.

(Indorsed) Filed Oct. 12, 1899.

S. W. BURNHAM,
Clerk.

United States Circuit Court,
Northern District of Illinois,
Northern Division.
} ss.

I, S. W. Burnham, Clerk of the Circuit Court of the United States for said District, do hereby certify the above and foregoing to be a true and complete copy of the complainant's Rebuttal Testimony filed in said Court, in the case of United States Repair and Guaranty Company, Complainant, against Assyrian Asphalt Company and James P. Mallette, defendants, as the same appears from the original thereof now on file in my office.

In Testimony Whereof, I have hereunto set my hand and affixed the seal of said Court at my office in the City of Chicago, in said District, this 13th day of October, 1899.

S. W. BURNHAM,
Clerk.

(Seal.)

Filed Oct. 14, 1899.

EDWARD M. HOLLOWAY,
Clerk.

343 IN THE CIRCUIT COURT OF THE UNITED STATES.

For the Northern District of Illinois.

United States Repair and Guaranty Company
vs.
Assyrian Asphalt Company et al
} In Chancery. No. 24,534.

To Messrs. Peirce & Fisher,
Solicitors for Defendants:

Please take notice that on Wednesday, February 23, 1898, before W. Clarence Duvall, a notary public in and for the City of Washington, District of Columbia, we shall proceed at 11 o'clock a. m. to take the testimony of Charles Elwood Foster and J. H. Cranford, of Washington, D. C., and William H. Lober, Charles H. Burwinkle and George Schwendeman, all of Philadelphia, and others, at the office of Messrs. Foster & Freeman, 931 F street, N. W., Washington, D. C., at which time and place you are invited to be present for the purpose of cross-examining the said witnesses and of examining exhibits to their depositions which may then be introduced in evidence.

Very respectfully,
RAYMOND & OMOHUNDRO,
Solicitors for Complainant.

Chicago, Ill., February 15, 1898.

Service of the above notice accepted this 17th day of February, 1898.

PEIRCE & FISHER,
Solicitors for Defendants.

345 IN THE CIRCUIT COURT OF THE UNITED STATES,

For the Northern District of Illinois,

Northern Division.

United States Repair & Guaranty Company
vs.
Assyrian Asphalt Company et al.
} Gen. No. 24,534.

COMPLAINANT'S REBUTTAL.

Testimony taken and evidence adduced on behalf of complainant pursuant to the attached notice and the stipulation subsisting between the parties, before W. Clarence Duvall, a notary public in and for the District of Columbia, at the offices of Messrs. Foster & Freeman, No. 931 F street, N. W., Washington, D. C., commencing at 11 o'clock a. m. on Wednesday, February 23rd, 1898.

Present: Mr. W. R. Omohundro. of Raymond & Omohundro, solicitors for complainant, and

Mr. James H. Peirce, of Peirce & Fisher, solicitors for defendants.

346 Whereupon CHARLES ELWOOD FOSTER, a witness produced on behalf of complainant, being first duly sworn, testified in answer to interrogatories propounded to him by W. R. Omohundro, Esq., as follows:

Q. 1. What is your name, age, residence and occupation?

A. Charles Elwood Foster; age 56; residence, Washington, D. C., occupation, patent attorney and mechanical expert.

Q. 2. State what experience you have had in the practice of your profession, tending to qualify you as an expert in patent causes and particularly in connection with matters pertaining to asphalt pavements and modes of and apparatus for laying the same.

A. I have been engaged in the practice of my profession since 1859. I am a practical mechanic, familiar with the use and operations of ordinary wood working and metal working tools and have for many years devoted a great deal of attention to mechanical subjects, consulting various text-books, and have had much expe-

rience in connection with the construction and manufacture of different mechanisms and devices. I have had frequent occasion to inspect the operations in the process of manufacturing and constructing various different apparatus and appliances, and have to a greater or less extent taken part in such constructions and have supervised or superintended the same. I also am a practical draftsman, and have made a great many thousands of drawings for illustrating constructions or as working drawings. I am an active member of the American Society of Mechanical Engineers, and for a couple of years was editor of the Patent Department of The American Exchange and Review, and I have devised
347 many different mechanical devices, apparatus and appliances, some of which have been patented and gone into extensive use.

In the course of my practice as an expert and solicitor I have had frequent occasion to examine the drawings and other records in the United States Patent Office and in public and private libraries and various publications, and also to visit various manufactories for the purpose of ascertaining the state of the art and of observing operations of mechanisms connected with the various different subject matters in different arts, and have frequently been called upon to give my opinion as an expert, both in private consultations and in causes pending before the United States courts, and to advise as an expert as to the construction and operation and efficiency and practicability of various mechanical constructions. I have also prepared and prosecuted many thousand applications for letters patent. During the course of my practice for many years I have frequently been called upon to examine into the state of the art of the making of paving compositions and of laying pavements, roofing, etc., and during the past three years I have given special attention to this matter and have investigated the records of the United States Patent Office and various publications, and consulted with many persons familiar with the art as pursued in the United States and foreign countries.

I have examined the preparation of different mixtures and compositions, as well as the operations upon the raw materials, and I have seen large numbers of composition pavements laid at different places, and have investigated the apparatus employed therefor, the manner and process of laying and preparing the same in different ways, and also of analyzing paving compositions
348 and mixtures and testing the same by laboratory tests, and have prepared and prosecuted different applications for letters

patent for mixtures, modes of preparing the mixtures, and apparatus therefor. I have at different times during the past three years directed and superintended the laying of asphalt pavements and repairs for the purpose of making tests and investigations, not only in connection with pavements of asphaltic mixtures, but pavements of rock asphalt.

Q. 3. Have you examined the Perkins patent in suit, No. 501,537, dated July 18, 1893, and if so, do you understand the improvements therein specified and claimed?

A. I have examined and I do understand the same.

Q. 4. Please state your understanding of the improvements set forth in said Perkins patent in suit and referred to in the claims thereof and more particularly to claim 1 of the said patent.

A. Referring to the patent in suit, I find that as stated in the preamble and in the claims, the invention relates to a method of preparing pavements of a character termed "asphalt pavements." Any one familiar with the art at the date of the application for the letters patent in suit would understand from the term "asphalt pavements" that there is meant a pavement consisting of a suitable foundation generally of hydraulic concrete, and what is termed in the patent "the surface material," the same consisting of a mixture of asphalt and a tempering material such as petroleum residuum, and heated sand. Such a surface material may be used with or without a binder coat. With a binder coat the surface material at the date of the patent in suit and at the present time would be from two to two and a half inches in thick-
349 ness and formed by mixing intimately together the melted asphalt and petroleum residuum and heated sand, forming a granular but somewhat pasty mass which in practice was carried in carts and so covered as to be preserved at the temperature above three hundred degrees Fahrenheit and which was spread upon the surface of the foundation layer. The heated mixture was then intimately distributed over the said surface and compressed and condensed by rolling and tamping generally by means of a steam roller, dry cement then being swept over the surface, which thereafter was rolled again with a steam roller. This surface material of asphalt pavements is liable to deteriorate from wear, from the gradual evaporation or washing away of the bituminous elements of the material, from the action of solvents resulting from animal droppings, and from rotting especially at places where water is allowed to stand continually or frequently. The wear does not take place evenly over the whole surface of the

pavement but generally is local, so that after a greater or less length of time, certain spots or portions of the pavement must be repaired. Again, repairs are frequently necessitated by a sinking of the surface of the pavement, resulting from imperfect foundations, the breaking of sewers, or the washing away of parts beneath, rendering it advisable to fill up the depressions in the surface material thus caused. The places to be repaired are generally indicated by an inspector who marks with chalk a line around each spot to be repaired, inclosing a space indicating the extent of the surface to be operated upon. These facts were well known to those skilled in the art at the date of the application for the patent in suit.

The patentee of the patent in suit in the specification first sets out briefly the prior method of repairing asphalt pavements
350 of the character to which the invention relates. Thus (lines 18 to 30) he describes this method as consisting of the following steps:

1. Digging out with a pick or other instrument the surface material. This relates to the entire material constituting the surface layers which in the method of repair at the date of the application of the patent in suit was invariably dug out down to the foundation layer, thus removing all of the surface material at that point and exposing the surface of the concrete, or binder coat when there is one.

2. It is stated that sometimes heat is applied to soften the material so that it may be more easily removed. This statement of the patent is correct, but the heating was generally not resorted to because it was found that the surface material of a concrete pavement could be dug out with greater facility when cold and brittle than when heated and tenacious. One method of applying heat when it was resorted to was to make a fire directly upon the surface of the pavement.

3. The next step consisted, as stated in the patent, in removing the material. This refers to the entire body of material, down to the foundation, leaving an excavation extending completely through the surface material.

4. The next step, as stated in the patent, consisted in thoroughly cleaning the depression formed by cutting away the material. This was necessary if any interval of time elapsed between cutting out the material and the ensuing operations, because the depressions thus formed would in a little while become more or less obstructed by dust, animal droppings, etc., and it was desir-

able that there should be no dust or dirt or foreign matter that would interfere with the making of a close contact between
351 the surface of the cut-away part and the new material.

5. It is stated that the depression is then given a coat or dressing of tar. Such coating was generally applied at the edges of the depression cut in the surface material.

6. The next step set forth in the patent consisted in placing in the depression new material in a heated state. This new material was of the same composition as that constituting the surface material of the pavement.

7. The new material is then ironed down and smoothed off in the usual manner. This would be understood by any one skilled in the art as consisting in pressing and coating with hydraulic cement, and rolling with a roller, heated irons being run over the meeting edges of the old and the new material.

The above described operations were those which usually at the date of the application for the patent in suit and sometimes at the present time, are employed in repairing pavements. They are still employed where the surface material in necessarily entirely removed to expose the top of the foundation, and any one skilled in the art, reading lines 18 to 30 in the specification of the patent in suit, would understand that this portion of the specification refers substantially to the above described operations.

After having thus referred to the then existing mode of effecting repairs in asphalt pavements, the patentee then goes on to state certain objections to this mode, as follows:

1. The line or joint between the old and the new material is discernible in such modes of repair, and sometimes there is a ridge. This refers to the edge or boundary joint between the old and the new material and to the then well known fact
352 that the two materials were frequently not perfectly welded together.

2. The parts are apt to separate at the joints. This separation might occur as stated "by reason of frost" which causes the parts to shrink. This frequently occurs to the extent of causing wide cracks across the whole width of the pavement. The separation is also said to occur "from other causes." This for instance would include sudden heavy blows on the new portion or block, especially during cold weather, or repeated lighter blows, which would sometimes displace the new block in consequence of the fact that there is comparatively slight adhesion between the block of new material and the surface of the concrete below so that if

from shrinkage or otherwise the side joints open the block might really become detached.

The patentee having then stated some, and only some, of the objections to the then existing mode of repair, goes on to state his invention as consisting of certain steps as follows:

1. Subjecting the spot to be repaired and the surrounding portion to heat sufficient to reduce "the surface asphalt" to "the soft pliable state in which it is originally laid." I understand that the term "surface asphalt" as used (lines 42, 82 and 83, page 1) refers to the surface of the asphaltic layer in contradistinction to the whole body of surface material and that the patentee proposes that the surface portion only of the surface material shall be reduced to the soft, pliable state described. The soft, pliable state in which the surface material is originally laid is a state in which all the particles are at a temperature of about 300 or 320 degrees Fahrenheit—in a semi-pasty semi-granular, sticky and almost molten condition.

353 2. The next step consists in so acting upon the old material of the pavement that it is "agitated." I understand by the word "agitated" to be meant that the heated pasty and nearly molten portion of the surface material is so worked upon "with a rake or other suitable instrument" that the heated material is stirred and displaced at the surface so as to open up and separate the particles at the surface portion so that this portion is no longer in a solid packed and consolidated condition comparatively smooth but the particles are separated from each other, some raised above the others. In order that this may be understood, I make a sketch illustrating the character of such a surface after being agitated as I understand it must be agitated with a suitable tool as called for in the specification, and I mark the same "Complainant's Exhibit, Foster Sketch." This represents generally the profile that the surface of an asphalt pavement would have after being heated and after having been agitated and picked by a tool as described in the specification of the patent in suit.

3. The next step called for in the patent consists in mixing with the stirred-up portion of the old material "enough new material to fill up the spot to be repaired." I understand that this requires that the new material which it is stated (lines 91 and 92), will be of substantially the same degree of softness as the heated old material, shall be combined with the stirred-up portion of the old material in such a way that the particles of the new material shall co-mingle with those of the old along the general plane

of union in such a way as to be practically integral therewith when the new material becomes cold, and as will result when the surface
of the material has been stirred and picked and opened up to
354 permit the particles of the new material to penetrate the
interstices thus formed. I understand from the use of the expression "enough new material *to fill up* the spot to be repaired" that some of the old material is removed for otherwise there would be no space to be filled up. The removal of a certain portion of the old material in most cases is necessary because it is not desirable that the spot which is repaired shall be at a higher level than the surrounding portions of the pavement. Further, where repairs are required, there has generally been a certain amount of disintegration of the old pavement leaving on the surface what is termed "dead material," resulting from the evaporation of the volatile parts of the asphaltic mixture. There is further upon the surface of the heated portion after the application of the heating apparatus a thin film or coating resulting from the evaporation of the bituminous portions at the extreme surface of the pavement and which is generally, although not always, removed. This burnt portion and any dead portion would naturally be scraped away by any one skilled in the art in attempting to carry out the patentee's invention just as they would naturally without instructions cleanse the surface in the first instance before heating the same, and such person would also recognize that such removal would be the cause of *filling up* the spot as referred to in the patent in suit.

Noon recess.

4. The next step specified consists in the usual finishing operations of ironing and burnishing which would be the same in this case as when the pavement is repaired by cutting out all of the surface material.

The description of the new process by the patentee is stated
355 in a general way in lines 39 to 50, page 1, setting forth the
steps employed apart from the use of any special apparatus. The patentee then goes on to state that different means may be employed for heating the surface that he does not limit himself to any special apparatus, and then in connection with the drawing (lines 58 to 94, page 1), he gives another description of the steps employed in carrying out his invention with such apparatus. The said apparatus is portable and consists of a series of gasoline burners arranged beneath a hood with an air pump for producing a

pressure by means of which the gasolene is expelled and the flame driven upon the surface to be heated. It is stated that with this apparatus not only is the immediate surface heated "but the particles deep down (are caused) to be melted yet not burned." Reference is also made to filling up the depressions, from which it is evident that the patentee recognizes that a certain portion will be removed to be replaced by the new material. Then the underlying portion in its softened or melted condition can be agitated by means of the rake so as to loosen or pick up the particles whereby when the new material is added in its heated or softened condition, the two will be mixed together along the plane of contact. After the usual rolling, tamping and finishing operations, it is stated that the material will then be united "without any distinct dividing line * * * because the new material has been mixed with and become a part of the old material." In other words, the new and the old are welded together. Reference is also made to the fact (page 2, line 5) that the new material is worked into the edges of the surrounding spot by means of the finishing operations. The fact that by such operations the new material thus applied 356 and the old material become actually welded together and without any dividing line is one beyond any question, as I have found by cutting transversely through pavements where repairs have been made in the manner set forth in the patent in suit. In such case it is frequently impossible to determine the line between the old and the new material, and it is only possible to do so when the new material differs in color from the old.

While such an apparatus is described for use in carrying out the patentee's process, I do not understand that any specific form of apparatus is necessarily demanded in view of the statement of the specification lines 50 to 57, page 1, and further in view of the fact that the claims are for a method or process and not limited to the mechanism employed.

The specification states, in connection with the process as described in connection with the apparatus as illustrated in the drawing that the pavement is repaired "without the use of tar *for the purpose* of uniting the parts or sections of material." I understand that the patentee is here drawing a distinction between the necessities and advantages of his process and those of the process formerly in use. In the old process, the tar, which would melt at a lower temperature than the pavement material serves as a solder or means of uniting the edges of the block and of the recess in which the block was formed. It constituted a part between the

two and in the case of the expansion of the block might be forced out, forming a ridge as stated in the specification, page 1, line 35. With the new process, however, no intermediate or soldering medium is required, the union as stated being effected so completely that there is no "distinct dividing line between the old and new material * * * so that when hardened it is practically
357 impossible to tell where the pavement has been repaired."

The patent does not state that tar should not be employed under any conditions, but simply that it is not required "for the purpose of uniting the parts." I recognize this statement as a correct statement of facts inasmuch as I can say as the result of my own observation and operations that if the steps set forth in the patent are carried on consecutively and the new material in its heated and softened condition is deposited upon the old before there has been any time for the collection of dust or other material, the two will weld together perfectly no tar or cement being used. It is a common practice to deposit the new material upon the old after the latter has been agitated as described in the patent when such deposit can immediately follow the operations upon the old part of the pavement. I can also state as within my own personal knowledge that a good and in fact perfect weld may be secured even if the old material should become perfectly cold or chilled before the new material is deposited upon it because the latter in its highly heated condition, say 320 degrees F. when deposited upon the raised and picked up portions of the old material will surround the same and heat, soften and weld with the latter, forming a perfect weld between the two as described in the patent.

I do not find, however, that there is anything in the patent which sets forth that a cement would be detrimental, but merely that there is no necessity for using it for purposes of union. In the first general description of the process set forth in column 1, page 1, without reference to any special apparatus, no reference is made to the use of tar or to dispensing with it.

The claims of the patent in suit each relate to the same process set forth in the specification, of repairing an asphalt pave-
358 ment, the first in general and the second in specific terms.

The first claim calls for a method of repairing asphalt pavements. I understand that this refers to pavements of the character indicated in the specification of the patent in suit, that is, those having a surface material capable of being reduced to a melted or semi-melted condition by heat. The first step specified in the

claim is "subjecting the spot to be repaired to heat." I understand that this refers to the operation set forth in the specification wherein the upper part of the surface material is heated until it is reduced to a soft or molten condition. The next step specifically named in claim 1 consists of "adding new material." *As I before stated, in order to add the new material to the old in contradistinction to merely laying it upon the old, the specification sets forth the preliminary agitation and picking up of the heated portion of the pavement.* It further sets forth the purpose of heating the upper portion of the pavement which is that it may be agitated or stirred or picked up, and therefore while I do not find it specifically stated in claim 1 that the heated part is to be agitated, I do find that claim 1 calls for the heating, that the heating is for the purpose of permitting agitation, and that it calls for adding the new material which can only be effected as described in the specification by first agitating the heated part of the old material. Claim 1 does not call for the mixing of the old and the new material together, but when the old material is agitated or picked up the addition of new material causes the two to be mixed along the line of union as a necessary sequence to the operations. Further, claim 1 ends with the words "substantially as described," and

I find from the description that the heating is for the pur-
359 pose of agitation, and that the addition of the new material results in the mixing, and that an asphalt pavement could not be repaired by the method substantially as described and by heating and adding new material as set forth in claim 1 without first agitating the heated portion of the old pavement and then necessarily mixing the new portion with the old at the point or plane of union, as a consequence of adding the new to the old. The claim then calls for "smoothing and burnishing." As set forth in the specification, this is the usual smoothing and burnishing of iron around the edges, the smoothing being effected by roller pressure.

Q. 5. Have you read the stipulation of facts between the parties hereto, set forth upon pages 21 and 22 of Complainant's Prima Facie Record in this case, and do you understand the method of repairing asphalt pavements described in said stipulation?

A. I believe I understand the method of repairing asphalt pavement as set forth in the said stipulation which I have read.

Q. 6. Compare the method of repairing asphalt pavements set forth in said stipulation with the method of repair set forth

in the patent in suit, and claimed in claim 1 thereof, and state whether or not you find that the method of said stipulation is the method described and claimed in said patent, stating fully your reasons for any opinion which you may express?

A. Referring first to the method of repair set forth in the stipulation, and which I will term the "stipulated method," I note that it is stated that the part of the aphalt pavement which has been softened is scraped out and removed, I recognize that the scraping away and removal of the parts of the asphalt pave-
360 ment in such a method or repair as the stipulated method is generally necessary and I shall in answering this question treat it as being carried out in pursuing said method, but I do not wish to be understood as considering that it is an essential step to such a method because in some instances as where the foundation sinks below the new pavement it is not necessary to remove any portion of the surface material, the thin layer carbonized or burnt by the actions of the heater being so small in quantity that it may be mixed with the fresh material without detriment.

Comparing the stipulated method with that set forth in the patent in suit which I will call the "patent method or process," I find—

1. That the stipulated method and the patent method are alike in that in neither is the surface material removed down to the foundation. This is not only attended with the results and advantages set forth in the patent in suit, but also results in a great reduction of expense, because less time is required to prepare the old material to receive the new, the labor and expense of cutting out a large amount of material and of keeping tools properly sharpened are avoided, the waste of a large amount of material constituting an available part of the old pavement is avoided, a correspondingly less amount of fresh material is required, and the integrity of the old pavement is to a great extent maintained inasmuch as the surface material is not cut entirely through.

2. The stipulated method and the patent method are alike in that the operations are conducted upon an asphalt pavement consisting of material which would become soft, pliable and molten by the application of heat whereby it is practicable to agitate
361 and open up the surface of the old material so that the new may be added to and weld with the old forming an integral structure without any line of demarcation.

3. The stipulated method and the patent method are alike in that in each the spot to be required in the surrounding edges is

subjected to heat sufficient to reduce the heated portion to a softened, pliable and molten state.

4. The two modes are alike in that in each the material in its softened condition after the application of heat is agitated, stirred and opened up, forming a loose, irregular, granular surface upon the old material.

5. The two modes are alike in that in each, fresh, heated and softened material of the same composition as the old material is applied to the roughened loosened surface of the old material so that particles of the new material mix with the particles of the old material and the two are welded together at all points along their plane of contact when the new material is compressed.

6. The two modes are alike in that after the new material is deposited to fill the spot to be repaired, it is smoothed and finished as in the case of a new pavement.

7. The two modes are alike in that they result in uniting the two parts or sections without any dividing line, because the new material is mixed with and becomes a part of the old pavement.

8. The two modes are alike in that in neither is the use of tar required for the purpose of uniting the parts or sections of material inasmuch as they will unite perfectly without such use.

I find therefore that the stipulated mode embodies every step or operation of the patent mode pursued upon the same ma-
362 terials having the same characteristics and carried out in like manner to effect the same results.

My attention is called to the fact that it has been testified on behalf of defendants, while not stated in the stipulation that in the defendants' mode of repair the edges of the opening are coated with dope or cement. I am aware that it is common in carrying out the process of the patent in suit to paint the edges of the openings or depressions with cement which is practically the same as the asphalt mixture without the sand and in a melted state. This is only done when the new material cannot be added at once after the old material has been operated upon, and it is done in order that there may be a smooth even surface to which dust and dirt will not adhere so that the opening can be readily cleaned out when the new hot material is to be added. It further tends to keep the particles of the old material at the edges in their opened up condition. It is not in any sense a solder because as soon as the hot new material is deposited the cement becomes incorporated with and a part of the material and is practically absorbed or lost so far as having any separate identity is concerned.

I do not regard this feature of difference between the defendants' mode and that of the patent as militating in any way against the fact that the two are the same for the reason that the use of the cement is merely an added feature which does not modify or detract from the efficacy and effect of the other steps of the process. Further, for the reason that there is no statement in the patent or requirement to the effect that the cement must be dispensed with in all cases but merely a statement that certain operations are performed and effects produced without the use of
363 tar for the purpose of uniting the parts. Further, the reference in the patent is to tar, a substance which in the old process was used as a solder, being a different material from any ingredient in the pavement and softening at a lower temperature, while the material used by defendants is not tar but a cement which is practically the same as the material of the pavement.

Comparing the stipulated method with claim 1 of the patent in suit, as I have before expressed my understanding of it, I find that the claim calls for repairing asphalt pavements by a method in which heat is used and new material added "substantially as described." I find that in the stipulated method the heat is used substantially as described in the patent in suit, that is, as specified in claim 1, the spot to be repaired is subjected to heat, and, as described, the heat is for the purpose of enabling the surface portion of the old material to be agitated in order that the new may be effectively added thereto.

I find also that in the stipulated method new material is added, substantially as described in the patent in suit, that is, the new material is deposited upon that part of the old surface which has been agitated and opened or picked up, and it is deposited in a highly heated condition.

I find also that as called for in claim 1, the stipulated method embodies the operations of smoothing and burnishing.

I therefore find that the stipulated method is the same method set forth and claimed in claim 1 of the patent in suit embodying the same steps as described in said claim and in the specification to which reference is made, carried out in the same manner to produce and producing the same effects or results. My attention
364 has been called to the fact that the defendants in carrying out their mode of process sometimes permit a certain interval of time to elapse between the operations upon the old material and the deposit of the new material. I do not regard this as embodying a step different from anything called for in the patent. There

is no statement in the patent that the steps shall be carried on consecutively without a substantial intermission of time, and in fact, this would not be understood by any one skilled in the art reading the specification because every one skilled in the art would recognize that in the repair of asphalt pavement by the method described, it in many instances would not be practicable to have the fresh material on hand to fill each depression immediately after the surface therein had been agitated. Those skilled in the art would recognize the fact that very frequently the place where the fresh material is prepared is several miles away from the point where the repairs are made and that the carts are frequently delayed in passing to and fro that sometimes the pavement is operated upon to soften the old material and prepared for the reception of the new just before the hour of stopping at night or at noon, and under the operations of the patent, as practically carried on, no attempt was made to insure the immediate addition of the new material after operating upon the surface of the old layer.

An expert like the patentee, Perkins, or any expert reading the patent in suit, would as a matter of course recognize these essential well known conditions and no one familiar with the art would have been misled into understanding that the mode of the patent embodied any immediate succession of steps so far as
365 the heating of the surface material and the deposit of the new material were concerned.

Adjourned to Thursday, Feb. 24, 1898, at 10:30 a. m.

Washington, Feb. 24, 1898, 10:30 a. m.

Met pursuant to adjournment:

Parties present as before.

Mr. Foster's testimony continued.

Q. 7. Have you read French Letters Patent to Crochet, No. 137,208, introduced into this case as Defendants' Exhibit Crochet Patent and if so, do you understand the same?

A. I have read and I do understand the French Letters Patent to Crochet.

Q. 8. State your understanding of the said Crochet patent and also whether or not you find set forth therein the process of the patent in suit?

A. I understand that the Crochet patent relates to a process for the repair and renewal of a compressed ashpalt pavement. At the date of the said letters patent to Crochet, and at the present date, there were and are practically two classes of asphalt paving materials in use in France, that is, those which are known as "compressed asphalt" and as "bitumens" or "mastics," both, however, made from rock asphalt. I find upon reading the Crochet patent that it relates to operations to be performed on a pavement of compressed asphalt, which pavements were and are made from Neufchatel or rock asphalt or Seyssel asphalt; that is, a limestone or sometimes a sandstone rock containing a certain percentage of mineral tar or bitumen and any one skilled in the art at the
366 date of the Crochet patent, reading the same, could without any positive statement in said patent, have understood that a rock asphalt pavement was the character of pavement upon which the patentee proposed to operate. The patent itself, however, states beyond a doubt the character of the material by setting forth its characteristics. For instance, the reference to the effect of the pick in starting or swelling up the adjacent parts indicates one of the characteristics of a pavement made of rock asphalt. A pavement made from an asphalt composition such as is in use today in the United States will crack or split under the action of a pick. The further reference in the specification to the effect of heat upon the pavement which "decrepitates and becomes friable" shows beyond a doubt that the pavement to be operated upon is a rock asphalt pavement, as no other kind of an asphalt pavement is thus affected by heat except rock asphalt. The statement that after the parts are heated the rake forms upon the part remaining "numerous striae" describes a result peculiar to a rock asphalt pavement for when heated the teeth of a rake will cut into the same and form scratches precisely as they would in the surface of dry solid clay or chalk. Again reference is made to the asphalt "in powder-like state." This alone would determine the character of material intended to be operated upon and with by the patentee because rock asphalt alone among asphaltic pavement materials is in a powdered condition whether cold or heated. I note, however, no statement in the Crochet patent requiring that the fresh material shall be heated.

For illustration I here produce a box containing rock or Seyssel asphalt in powder in the shape in which it is employed and which I have seen employed for laying pavements and I also produce a portion of such rock asphalt which has been heated by me

367 to above 300 degrees Fahrenheit. The effect of heat upon rock asphalt is not to materially change its powdered condition. It is not necessary to assume that the asphalt powder referred to in the Crochet patent must have been heated or was intended to be heated by the patentee in order to carry out his process because rock asphalt will weld under impact or pressure whether cold or hot, my own experiments tend to show that a better weld or consolidation can be obtained with the cold than with the heated material. I produce herewith a number of blocks of compressed asphalt which I made in a die by impact, consolidating thereby some of the material taken from the box of powder which I have produced. The box of asphalt powder is marked "Complainant's Exhibit Rock Asphalt Powder." That which has been heated is marked "Complainant's Exhibit Powdered Rock Asphalt After Heating" and the blocks are marked "Complainant's Exhibit Compressed Block Asphalt." It is a fact that the rock asphalt has been used upon roads when compressed thereon in a cold state. The usual purpose of heating rock asphalt is not to render it adhesive and capable of being consolidated and compacted but is just the reverse, that is, for the purpose of breaking it up into a powder, and sometimes instead of grinding the asphalt rock in order to fit it for pavement purposes, the said rock is reduced to a powder by the application of heat. The further reference in the Crochet patent to the use of the system for recharging streets "of bitumen" indicates the other class of rock asphalt pavements termed "mastics" and intended for light drivewavs and consisting of rock asphalt with the addition of a small percentage of mineral tar. The usual addition of the mineral tar to pave-
368 ments having stone for their foundation does not change the characteristics of what are called in the Crochet patent and what were then known as "compressed asphalt pavements." I have given a great deal of attention to the construction and composition of asphalt pavements during several years, and have read various works and articles on the subject and have conversed with many who are familiar with the art of laying such pavements, both in the United States and Europe, and I have no knowledge of the use of asphaltic mixtures, such mixtures, that is, as have the characteristics of the asphalt pavements at present in use in the United States and described in the Perkins patent in suit, as being employed in France at any day. I am aware that such asphalts as Trinidad asphalts have been used to a slight extent in France for paving purposes, but merely for the purpose of extracting the

more liquid portions or securing the bitumen to be used for tempering rock asphalt mixtures.

In laying pavements of the character specified in the Crochet patent the natural rock is reduced to a powder by heating or grinding; this powder is then generally but not always heated and is then spread upon the foundation and compressed or consolidated preferably first by tamping and then by rolling. A high degree of pressure and preferably percussion has been found desirable in order to consolidate the material in making pavements of this character for unless so consolidated, the material on cooling will retain its granular condition. The purpose of the patentee Crochet in effecting repairs of such a pavement in applying heat to the part to be repaired was to disintegrate or decrepitate the portion of pavement, and this he effected by the application of heat until that portion became friable. The word "friable" 369 fairly indicates the effect of the application of heat to rock asphalt as I have found in actual practice. That portion of the pavement at the surface heated beyond a certain limited temperature loses its slight elasticity and toughness and becomes friable and flakes and crumbles so that it can be readily scraped away or swept away, but the portion beneath is in its original hard, compacted condition and practically as regular as the upper surface of the unheated part of the pavement. The patentee, in order to "augment the adherence" of the additional material and secure some kind of mechanical union between the old and the new material roughens or striates the surface by scratching the same with the teeth of a rake. I have found that the only effect of the teeth of a rake in such a case is to form scratches such as would be made by the same instrument in ordinary chalk. The fresh material is then placed in the depression formed by the removal of the heated portion of the old material. There is no statement in the Crochet patent directly to the effect that this fresh material is to be hot, and it is *possible* that the patentee proposes to unite the parts under pressure alone. If I assume the fresh material in its powdered condition to be added in a heated state and then compressed under the high pressure necessary to compact it, it would simply constitute a slab or plug filling or plugging the opening in the same manner in which such material had been commonly employed in repairing rock asphalt pavements where the injured portion had been cut away by means of a pick. It is obvious to me that the Crochet patent describes a process which never did and never would go into any extended

practical use. Any one familiar with the characteristics of rock asphalt and of the effect of heat upon lime rock would recog-
370 nize at once upon reading the Crochet patent that it would be impossible to effect anything but a frictional union between the old and the new material even if the latter was heated under the conditions specified by the French patent. My knowledge of the characteristics of rock asphalt, as derived from reading, and in consultation with those familiar with its characteristics, at once led me to the above conclusions on my first reading of the Crochet patent and subsequently in order to avoid any possible error in the matter I carried out the process of repair proposed in the Crochet patent in the effort to repair a Seyssel pavement and my first opinion was fully confirmed. In so doing I heated the fresh material to over 300 degrees Fahrenheit. I heated the surface to be repaired by means of a heater substantially like the Perkins heater. I thoroughly scratched or striated the surface of the depression, and while the latter was still in a heated condition I deposited the heated powdered asphalt in the depression and had it thoroughly packed therein by means of rammers using greater pressure than would probably ordinarily be employed, and did everything which in my opinion would thoroughly carry out the process set forth in the Crochet patent and which would tend to secure a union with the old and the new material. Notwithstanding my careful attention to carrying out every detail specified in the Crochet patent, the only result was to form a solid block filling the depression, and on subsequently cutting out the repaired portion of the pavement, found that there was absolutely no welding of the old and the new parts but merely a frictional adhesion so that the new part readily separated from the old upon receiving a slight blow. I have further at different times endeavored to
371 weld together a compressed block of rock asphalt and a body of fresh material sometimes cold and sometimes heated by compacting the fresh material upon the already moulded block, but have never secured anything more than a mechanical adhesion, the parts separating under a very slight strain, and my experience in this respect corresponds fully with that stated by others with whom I have had occasion to converse. There is quite a large amount of Seyssel pavement in use in the United States at the present time, and I have repeatedly during the past three years made inquiries as to whether any repairs have been effected upon such pavements by any process like the Perkins process of the patent in suit and not only have not been able to learn of any such

operations having been effected but have been advised by those familiar with the Seyssel pavements that in their opinions they could not be effected; and I believe I am right in stating that this is a generally recognized fact among those skilled in the art. The only effect of the operations specified in the Crochet patent which, to my mind, is attended with any advantage is the disintegration of the pavement by the heat of the tray which is carried over the pavement which facilitates the removal of the portion heated, differing in this respect from the effect of heating a pavement of asphalt mixture and I recognize that by "the *repeated* passage of the movable furnace," referred to in the Crochet patent, the rock asphalt pavement might finally be disintegrated to any desired depth so as to permit the introduction of a very substantial plug of new material.

Comparing the asphalt mixture of the character operated upon in securing the result set forth in the Perkins patent and the
372 material of the Crochet patent, they are essentially different in many of their characteristics. Thus the rock asphalt is in the form of a powder, after it is ground and whether it is hot or cold. The asphalt mixture when heated is pasty, slightly granular but not friable. The grains are not loose but sticky and adhesive. The rock asphalt when cold is in the form of a brown powder. The asphalt mixture when cold is a substantially solid mass, so tough and solid that it is with difficulty broken by a pick. I here produce a specimen of such a mass of asphaltic mixture as it fell from a cart in this city a few days ago, and the same is marked "Complainant's Exhibit Asphalt Mixture." The asphalt mixture when cold is tough and solid even when it has not been subjected to pressure, while under similar conditions the rock asphalt is still a loose powder. After the rock asphalt has been compressed and consolidated the application of heat disintegrates it and causes portions to flake off and renders all the heated part friable so that it will readily break or crumble and become sandy. The asphalt mixture when heated after compression to any degree short of burning becomes sticky, pasty, soft, partially melted and easily worked, being very much of the consistency of fresh mortar. The application of heat to compressed rock asphalt while it softens and breaks it up does not impart to it any adhesive characteristics while the application of heat to asphalt mixture after compression melts the asphalt therein, renders it soft and pasty and sticky and imparts a fresh lustrous surface so that it will adhere readily to fresh material. After the removal of the surface portion of a

heated rock asphalt pavement the application of a rake to the part
below simply scratches the hard surface of the unimpaired
373 portion. After the application of heat to a pavement of as-
phalt mixture the effect of the rake is to penetrate the soft-
ened and partially melted body of material lifting it up and separating the particles very much as the rake would operate upon a layer of fresh mortar. Upon the addition of fresh material to the old material in a rock asphalt pavement there is no admixture of the old and the new and the effect of pressure is not in the welding of the parts of the old and the new together. Upon the addition of fresh material to the opened up surface of the old material in a pavement of asphalt mixture the particles of the two are commingled or mixed along the plane of union and there is, as I have found by repeated tests, such a close welding that the new part is practically integral with the old, so that as stated by the patentee Perkins "there is no dividing line because the new material has been mixed with and become a part of the old material." Apart from the fact that the patentee Crochet makes no statement as to whether the fresh material is to be hot or cold, I still find that the Crochet patent does not set forth the process of the patent in suit, because it does not describe a process embodying the same operations upon the same material to secure the same result. If I assume that the operations specified in the Crochet patent are the same as those set forth in the patent in suit their effect on the material is so entirely different in its characteristics that it does not constitute the same mode or process any more than a series of steps upon syrup to clarify it constitutes the same process as the same steps upon coal oil to refine it. Neither are the operations of the Crochet patent accompanied by the same results as the operations specified upon the material of the Perkins patent. In
one case there is an absolute welding together of two ma-
374 terials so that after renewal the pavement is practically in the
same condition as when it was first laid. In the operations of the Crochet patent, there is practically no welding of the old and new parts but simply the accurate fitting and consolidation or plugging up of the depression in the old material with a solid block of new material with a very clear line of demarcation between the two, permitting a ready separation. I recognize that the patentee Crochet proposed to solder the new material perfectly to the old without break in continuity but I cannot recognize this as a statement to the effect that the new pavement is thereby homogeneous because the process set forth in the Crochet patent is altogether

ineffective to such a result. I therefore fail to find set forth in the Crochet patent the process of repairing pavements specified in the patent in suit.

Noon recess.

Q. 9. State whether or not at the date of the application for the letters patent in suit the Crochet French patent gave sufficient knowledge to the public to enable those skilled in the art, without the exercise of invention, to effectively repair pavements made of asphalt mixture?

A. I fail to recognize that any such information was given by the Crochet French patent, or that it gave any information of value to those skilled in the art. On the contrary, the effect of the statements of the Crochet French patent upon one skilled in the art would probably be to discourage the use of the steps specified in that patent. Anyone familiar with the characteristics of rock asphalt would upon reading the description in the patent, set aside the process if intended to secure a welding union between the old and the new, described in said patent, as visionary and impracticable, except to the extent to which it would plug up
375 an opening with a material separable from the old material. There is nothing whatever in the Crochet patent which would enable anyone to know that the hard, compressed material of an asphalt mixture pavement could, after it had long been in use, be so softened and opened up without burning and so intimately combined with fresh material as to effect an absolute weld or union of the two. I am confirmed in this opinion by the fact that notwithstanding the existence of the French patent, presumably well known to many skilled in the art, it was the universal practice up to the date of the Perkins invention to effect repairs by means of the ineffective and expensive laborious process of cutting away the entire surface mixture to the hydraulic concrete foundation.

It is true that the Crochet patent sets forth that by the application of heat to the surface of a rock asphalt pavement the heated portion of the latter may be disintegrated and readily removed, but no one on being made acquainted with this fact which was known before the date of the Crochet patent would know that it would be practicable to operate upon the surface of a compressed asphalt pavement without disintegrating it but merely so as to melt and soften and reduce it to the pasty condition in which it was laid. Any one familiar with the characteristics of an asphalt mixture pavement and also familiar with the absolute destruction

of the same as sometimes happens from building fires thereon would suppose that any other result would ensue upon the attempt to carry out the process set forth in the Perkins patent in suit. Naturally any one skilled in the art would assume that the application of sufficient heat to secure the softening of the lower body of material would result in practically destroying or burning out so much of the material as would defeat the purpose of the
376 operation. It is only from actual experiment that one learns the fact that upon the application of a blow pipe blast as suggested in the patent in suit there at once forms upon the extreme upper surface a thin carbonaceous crust which practically protects all of the material below from overheating and reduces it to a pasty or molten condition for a considerable depth. This is the very opposite of the suggestion of the Crochet patent that the effect of heat is to disintegrate or decrepitate the material for a depth of a half an inch or more.

Q. 10. State whether or not if the process and apparatus of the Crochet French patent were to-day used in repairing asphalt pavements, consisting of an asphaltic mixture employing the precise steps and apparatus described in said patent, an effective operation would result?

A. In such a case an effective operation would not result. The patent prescribes that the old pavement is to be heated until the portion heated becomes friable. This would be practicable with a rock asphalt pavement with the apparatus specified and illustrated in the French patent, and this would result in the absolute destruction of an asphalt mixture pavement, because the underneath portion would become so highly heated as to lose its bituminous and adhesive characteristics and be unserviceable. There is no intimation in the French patent of any modification of the process in its application to different purposes, and therefore any one literally following the said patent upon an asphalt mixture pavement would destructively burn the latter.

Q. 11. Have you read Defendants' Exhibits Malo Articles
377 Nos. 1, 2 and 3, Beckwith Article, Engineering Article, Chabrier Article, Correspondence on Asphalt and Malo Book and the several translations thereof, and if so, please state whether you find in any of said exhibits any more or better information or instructions regarding the repair of asphalt pavements than you find in the Crochet patent; whether you find any reference to or description of the "asphaltic mixture" pavements in common use in this country at the date of the Perkins patent in suit; and whether

you find therein any support for your conclusions regarding the Crochet patent and the disclosures therein, and particularly with reference to the kind of pavements treated of and the instructions given to those skilled in the art?

A. I have read the said Exhibit Articles and find the therein statements which correspond substantially with other statements relating to asphalt pavements in various other publications which I have read from time to time. Without going into detail I would state that I find that the articles referred to to point out the use of rock asphalt in making pavements called "compressed asphalt pavements," and those termed "mastics." They also point out the common method of repair of rock asphalt pavements by cutting through to the hydraulic foundation or "beton." They also refer to the fact that for a limited time repairs had been made by first heating the compressed asphalt to render it friable or disintegrate it, then scraping away, repeating this for any desired number of times and then plugging up the opening. I do not find any statement anywhere to the effect that after cutting any pavement so repaired the old and the new material were found to be welded together. If such statement had been made it would not be a true statement, for it is absolutely a fact that the 378 new material cannot be applied to the old and compressed thereon if either or both are hot or cold so as to unite the two forming a homogeneous article or structure. I would refer to the Chambrier article, page 283, as showing how much more adhesive rock asphalt is when cold than when heated which is the reverse of what is the case with asphalt mixture, and I would refer to the section at the top of page 290 as substantiating what I have said about the effect of heat in reducing the consistency of rock asphalt. The article termed Bridge and Highway Annals, etc., under the fourth heading "Extraction and Preparation of Bitumens, etc.," refers to the use made of Trinidad asphalt for securing a bituminous oil which is thereafter used for other purposes and this article further on refers to the laying of pavements by compressing the rock asphalt cold, but I cannot agree with the statement therein that this does not result in giving so homogeneous and solid a body as when the rock asphalt is compressed in a heated state, and it appears to me that the writer treats the matter theoretically only. Where such results were not obtained it was probably owing to the presence of moisture or to a defective foundation which would not allow sufficient pressure.

I do not find that any of the said articles go further than the

Crochet patent in describing a means of readily forming the c
pressions in a rock asphalt pavement and plugging them up. I do not find that any of them even hint at the use of such pavement compositions as constitute the asphaltic mixture pavements upon which the Perkins process could be employed, and I further find
379 that in all those cases where reference is made to plugging rock asphalt pavement by the steps described in the Crochet patent, this mode is alluded to in such terms as to indicate that the same was experimental in its character at the time. There is nothing stated as to the character of the pavement so repaired, the usage to which they were subjected, and nothing to show that the repairs resulted in anything more than plugging up an opening with compressed asphalt without any real union between the old and the new parts. No one skilled in the art could understand from any one of these publications that it would be practicable to heat and melt the surface portion of an asphalt mixture pavement without destructively burning a large proportion of the same, nor could they have known this fact from said statements and without the necessity of actual experiment and demonstration.

Q. 12. Have you examined and do you understand the inventions or improvements set forth in, Letters Patent No. 560,599, in suit granted to Amos H. Perkins, May 19, 1896?

A. I have examined the said patent and I understand the apparatus therein set forth.

Q. 13. Please state your understanding of the invention described and claimed in said Letters Patent, and also compare the same with Complainant's Exhibit Defendants' Device and state whether you find in said device the invention described in said Letters Patent and summed up in the claims thereof.

A. Referring to Letters Patent 560,599, I find that it relates to that class of apparatus for repairing asphalt pavements in which a hood is carried to a position above the parts to be repaired and a mixture of gas and air is burned beneath the hood in order to soften the surface of the latter. In prior constructions certain
380 objections arose in practice pointed out in the specification of patent 560,599, such, for instance, as the escape of flame and heat around the edges of the hood which could not be brought close to the pavement without cutting off the air supply —the burning out of the valve of the numerous burners previously employed—and the necessity of using a high grade of burning fluid. The patentee sets forth that he overcomes these objections

by the use among other things of a hood which is open at one end. This permits the hood to be set directly upon the ground if necessary while sufficient air can get access to the burners even if they were arranged within the hood. An arrangement is shown, however, with the burners outside of the closed end of the hood and projecting into or towards openings in the hood constituting a sort of Bunsen burner whereby the jets of flame are projected horizontally from one end without any tendency to direct the blast beneath the edges of the hood even should the latter be elevated from the pavement. Instead of a series of burners arranged beneath the hood the patentee makes use of burners arranged to discharge the flame horizontally into the hood from the direction of the closed end thereof with a supply pipe leading from a reservoir beneath the hood in position therein to be heated by the flame projected from the burners to which the supply pipe extends. By this means the use of numerous joints is prevented, the oil being vaporized in the pipes by the flame from the burners which are arranged back of the point where the heat is generated so that they are not burned out, while the burners may consist simply of short tight nozzles without valves and permitting the use of light oils without pressure or of heavy oils with an artificial pressure in the tank. As shown the whole apparatus is mounted upon
381 wheels so as to be portable. In Fig. 7 of the drawing and page 2 of the specifications, line 110 et seq., there is shown and described a modification in which the burner has a hood P projecting through the rear end of the hood H.

Referring to the claims, I find that they all relate to an apparatus for repairing asphalt pavements. Each claim calls for a hood and all of the claims except claim 4 require that the hood shall be closed at one end and open at the other. Each claim calls for one or more burners. Claims 1, 4 and 5 require that the burners shall be arranged to discharge horizontaly into the hood. I understand this to mean that the arrangement of the burners is such that the gas therefrom shall pass horizontally from the burners within the hood either from the burner arranged wholly outside of the end of the hood, as shown in Figs. 1 to 5, or with a part of the burner extending into and through the wall of the hood as shown in Fig. 7. I do not understand that the difference is material as regards the requirements of the claims, as in either case the flame passes longitudinally through the hood and in contact with the pavement. From the word "horizontally" I understand that this

is the general direction of the flame as called for in the claims where that word is used. Claim 2 calls for the burners arranged to discharge into the other or closed end of the hood without any limitation as to the flames being horizontal. Under the terms of this claim as well as under the terms of claim 3, the burners might be arranged at an angle and yet the combination would come within the terms of these claims.

Claim 3 calls for perforations in the closed end of the hood and burners arranged to discharge into the hood through such perforations. I understand that this relates to the specific
382 arrangement of burners outside of the hood opposite perforations in the closed end, the flame or gas from the burner passing through the perforations before entering the hood.

Claim 4 embodies the additional element of the supply pipe which of course is implied in the other claims, but it requires that the same shall be disposed underneath the hood, and I understand that thereby the oil passing through the pipe is oxidized by the heat of the pipe imparted by the flames from the burners. Claim 5 also calls for the supply pipe passing beneath the hood and has the further limitation that the pipe shall extend and terminate at a point beyond one end of the hood.

Claims 1, 2, 3 have no limitation as to the portability of the apparatus, and any hood which had the other features of the said claims combined with it would be in the combination called for in the said claims. I recognize, however, to come within the general requirements of the said patent, the apparatus should be capable of transportation from place to place upon the pavement as required, but without any limitation as to any particular means of mounting the apparatus. Claims 4 and 5 call for a portably mounted reservoir which I understand to require that some means as, for instance, wheels or runners, shall be provided whereby the reservoir and the parts combined therewith can be readily shifted in position. Referring to Complainant's Exhibit Defendants' Device, as shown in "Complainant's Exhibit Defendants' Device," I find therein the following elements of the claims of patent 560,599. I find that said Defendants' Device is an apparatus for repairing asphaltic pavements. I find therein a hood which is open at one end and closed at the other as well as at the top and
383 sides. I find that the closed end of the hood has two perforations therein. I find that there are two burners and that the said burners are arranged to discharge horizontally into the hood, that is, they project through the openings in the end of the hood

so that the flame passes horizontally substantially the whole length of the hood or can do so if of sufficient length. I find a supply pipe which leads from a reservoir, and I find that it is disposed underneath the hood so that the flames from the burners will cause the same to be heated. I also find that the supply pipe terminates at a point beyond one end of the hood and is connected with the burners. I also find that the reservoir is portably mounted upon wheels so that the reservoir and parts combined therewith can be readily carried from place to place, and I also find that in use the hood will confine the heat within its own limits as specified in the claims, that the burners are not in position to be affected by the heat, that the hood may rest directly upon the surface of the pavement, and that the burners need not be provided with valves. While I do not find that the defendants' apparatus has burners arranged to discharge into the hood through the perforations at the end literally as described and illustrated in the drawings of the Perkins patent 560,599, I do find that they are arranged to discharge into the hood. and that the gases discharged by the burners are conducted thereby through the perforations so as to effect all that would be required if the burners were set back with their ends a short distance outside of the end of the hood and opposite the perforations and I fail to recognize any practical difference in the slight difference in the position of the burners. The same result would ensue in both cases practically, and I must consider then substantially the same thing. If the Court should con-
384 strue the claim literally, however, to require that the gases from the burners must leave the burners before passing through the openings, then in that case I would not find the combination of claim 3 in Defendants' construction.

Adjourned to Friday, Feb. 25, 1898, at 10:30 a. m.

Washington, D. C., Friday, Feb. 25, 1898, 10:30 a. m.

Met pursuant to adjournment.

Parties present as before.

Q. 14. Please compare with the patent in suit No. 560,599 and with the invention described and claimed therein, the U. S. Letters Patents set up by Defendants as showing the prior state of the art and state whether you find in any of said patent, the invention described and claimed in the said patent in suit, or whether

you find therein any construction embodying any claims of said patent in suit, in your opinion?

A. I have made the comparisons called for and will refer to the different Letters Patent seriatim.

Craig's patent 8701. This shows the plate mounted on runners and carrying the fire box through which a blast is directed to carry the hot gases below the fire box onto the grass, weeds, etc. Comparing this with the Perkins claims, it does not show any hood, the space below the plate being open at both ends and incapable of confining heat longitudinally nor does it show any burners or any means of directing flame horizontally.

Bogia's patent 5697. This is an apparatus for removing snow provided with a platform, the space below which is not enclosed in any way. The platform supports a blast furnace which
385 directs gases downward in front of the platform. This apparatus does not embody the hood or the confining heating space or the burners of the claims of the Perkins patent.

Waterbury's patent 145,822. This is a snow melting machine having a platform below which are sides E and a front G with a furnace above through which a blast is driven downward into a space below the platform. This shows a hood with a space closed at the top sides and one end, but it does not show or embody any burners arranged horizontally or otherwise nor any means for directing discharged gases horizontally nor does it show any reservoir or pipe leading therefrom and to burners as called for in the Perkins claims.

Waterbury's patent 157,559 in its general structure is like that of patent 145,822, but there is an arrangement for discharging steam jets into hydrocarbon burners driving the flame vertically downward. There is no arrangement of burners to discharge horizontally or into the end of the hood either from the outside or within the same, nor is there any supply pipe arranged beneath the hood as called for in the claims of the Perkins patent.

Hayes' patent 169,439. This is a device for burning paint from painted surfaces and consists of a burner at the end of a pipe C which is coiled so that the flames from the burner shall pass across the coil inside of a conical flame tube B. These parts together constitute practically the burner which is supplied from a reservoir. The end of the burner extends into a guard or shield D consisting of a flat plate bent down at opposite sides. Assuming that I can term the guard plate or shield a hood, it is not a hood closed

at the sides and one end, nor is it provided with an end hav-
386 ing perforations, nor is there any supply pipe extending be-
neath the hood, as called for in the claims of the Perkins patent. The flame tube B cannot be considered the hood, as it is practically a part of the burner. Assuming, however, that it is to be compared with the hood of the Perkins patent, it is not closed at one end as called for, nor is it open at the bottom.

Kendrick's patent 184,628. This is an apparatus for melting snow from tracks and corresponds with the apparatus of the Craig patent 8701 in its general features, except that it is upon wheels instead of runners and is open at its forward end with burners F directing the flame downward. The burners are arranged in what is termed a combustion chamber "T," which seems to be an oblong box suspended by bolts *h*, Fig. 3. This, I understand, is enclosed at the top and on all sides. I do not find in this construction the hood open at one end only or burners arranged to discharge into the end of the hood either from the inside or outside or perforations for the passage of burners discharging horizontally, nor a supply pipe to heat a hood communicating with the burners.

Zimmerling patent 269,368. This is a combined flat iron and heater, the heater having a burner at F, F' supplied with oil from an elevated reservoir and directing the flame into a feed tube C_2 which is connected with the burner. The burner and tube are passed through an opening in the rear wall of the flat iron which is a practically closed box except for the purpose of air holes A' and the rear hole for the passage of the burner and which is reversible so that the top when sufficiently heated by the flame from the burner can be brought underneath. In other words, the burner
acts to heat the top of the box which is the reverse of the
387 action of the flame from the burners in the Perkins apparatus.
I find nothing in this flat iron structure corresponding to the hood open at the bottom and one end or the combination of such a hood and end burners or burner as called for in the claims of the Perkins patent, I do not find the supply pipe arranged to be heated by the burner but no claim is made for this by itself and apart from the particular combination in the Perkins patent.

Curl's patent 383,346. This also shows a flat iron consisting of a reversible block into which a burner extends through a hole in the rear the flame from the burner heating the supply pipe. The remarks I have made concerning the structure of Zimmerling's patent 269,368 apply equally to that of Curl's patent 383,346.

Risdon & Toliver patent 531,648. This is an apparatus for firing grass. There is no hood but two side guards A', A' the space between them being open at top, bottom, and end. There are burners B near the center of this space supplied from a reservoir. I do not find in this structure any hood or any burners discharging into a hood, nor any perforations in the end of a hood, nor any supply pipe beneath a hood and communicating with burners as called for in the claims of the Perkins patent

Considering these various patents together I do not find that any one of them embodies the combination of any one of the claims of the Perkins patent, nor that they set forth a structure which is capable of use like that of the Perkins patent in suit for the purpose of projecting a flame or flames horizontally over a pavement confining the heat to the pavement without heating the burners and affording a proper supply of air for combustion to the burners. I find that some of the apparatus have hood, more
388 or less open and means for directing air blasts downward but these would not remedy the difficulties which were remedied by the structure of the Perkins patent in suit, as set forth therein. Further, their use would be attended with great danger of such unequal action as would burn one part of the pavement while insufficiently heating another, and I fail to find anything in any one of the structures or in all together that would naturally suggest to anyone skilled in the art the use of the combinations or any of them set forth in the claims of the Perkins patent in suit.

I can state as within my own knowledge that the construction of said Perkins patent 560,599 was only arrived at after a large number of experiments with preceding structures extending over a considerable time and involving quite a large amount of expense, and I have myself seen large numbers of these discarded and experimental or partly experimental structures among waste material in the shops.

Counsel for complainant here offers in evidence the sketch referred to by the witness in his answer to Q. 4, on page 10 of the typewritten record, and the same is marked "Complainant's Exhibit Foster Sketch."

Counsel for complainant also offers in evidence the several samples referred to by the witness on pages 27 and 33 of the typewritten record under the titles designated by the witness, as follows:

"Complainant's Exhibit Rock Asphalt Powder."

"Complainant's Exhibit Powdered Rock Asphalt after Heating."

389 "Complainant's Exhibit Compressed Rock Asphalt."
"Complainant's Exhibit Asphalt Mixture."

Counsel for complainant, in view of the proofs of defendant as to the character of the valve K of defendants' machine, and as illustrated in Complainant's Exhibit Drawing Defendants' Device, notice is hereby given on the record that infringement of Letters Patent in suit No. 542,349, apparatus for repairing asphalt pavement, granted A. H. Perkins July 9, 1895, will not be further urged in this suit, and that at a proper time, of which defendants will be given notice, leave will be asked of the court to dismiss as to so much of complainant's bill as relates to said patent, without prejudice.

Mr. Peirce—Defendants' solicitor denies the right of complainant to dismiss its bill in respect to patent No. 542,349 "without prejudice"; the issue being framed in respect to the infringement of said patent defendants are entitled to have such issues tried along with the others unless it be conceded that the defendants' device does not evade said patent.

Counsel for complainant not having been afforded an opportunity for examining all of the apparatus used by the defendants, is unable to concede as to any apparatus regarding which it is not now informed. In view of the objection made by counsel for defendants, counsel for complainant desires to withdraw his notice on the record as to patent No. 542,349.

Cross-Examination by Mr. Peirce.

X-Q. 15. It appears in evidence that "The Barber Asphalt Paving Co.," a corporation under the laws of West Virginia,
390 is a licensee under the Perkins patent here in suit; what, if any, professional relation do you sustain towards said company?

A. I have for several years been one of the solicitors and experts for the Barber Company.

X-Q. 16. Who is the President of the company,

Objected to as irrevelant and immaterial, and also as incompetent.

A. Col. F. V. Greene is President, I believe.

X-Q. 17. Has that company a general office in New York City?

A. It has.

X-Q. 18. At one time Col. Greene was an engineer commissioner of the District of Columbia, was he not?

A. I believe that he was from what I have heard. I never met him in that capacity.

X-Q. 19. How long to your knowledge has Col. Greene been connected with the Barber Company?

A. To my knowledge about three years, how much longer, I don't know.

X-Q. 20. Do you regard him to be competent authority on the subject of asphalt pavements?

A. Upon some points possibly. Of course he is an engineer and I understood that he has given the subject of asphalt pavements a good deal of attention. Whether or not he is competent to speak of details of such matters from actual personal operations I do not know.

X-Q. 21. As the term "asphalt mixture" is used in the course of your testimony, I understand that it covers a compound
391 of asphalt, a tempering material—such as petroleum residuum —and heated sand. Am I correct?

A. Generally speaking, yes. The asphalt is generally refined, and sometimes there may be a little stone dust.

X-Q. 22. In about what proportions are these several ingredients admixed?

A. The amount of petroleum and residuum to the asphalt forming what is called the cement will vary somewhat according to the character of the pavement intended and the geographical location. You may assume generally 10 per cent of residuum. The cement and sand are used, roughly speaking, in the proportion of 15 of cement to 85 of sand.

X-Q. 23. Compare the geographical location of Buffalo with that of Washington. For the same traffic, in which pavement would the residuum enter in larger proportion?

A. There would be less residuum in the warmer climate. The difference is very slight, generally not over three or four per cent between extreme climates, and different parties have different views as to the proper proportions.

X-Q. 24. Speaking in round numbers, according to the general data just stated by answer, am I to understand that the asphalt mixture as a whole consists of about 15 per cent asphalt, 8 per cent residuum and 77 per cent sand; am I correct?

A. Approximately that would be the proportion of the ingredients put into the mixture; undoubtedly in the course of heating and laying and also in the course of use a certain proportion
392 of the residuum or the more volatile elements thereof would disappear.

X-Q. 25. What is the object of adding the residuum to the refined asphalt?

A. It was found upon making the first experiments with asphalt mixtures in laying pavements that the pavements would flake off and crack, especially in cold weather, and the use of petroleum oil and petroleum residuum was finally resorted to to correct this defect, and after the proper proportions were discovered proved to be effective. It was some years after pavements began to be laid before these facts were fully approved and recognized.

X-Q. 26. In making up the asphalt mixture, you speak of the use of "hot" sand; why should the sand be hot?

A. In most instances the sand is received in a wet condition, sometimes so wet that the water runs from it, and one of the most difficult problems in making asphalt pavements is to get the sand dry, because the presence of any moisture prevents adhesion between the particles of sand and the asphalt. Naturally in this drying operation the sand becomes heated. Assuming the same to be absolutely dry, I know of no other reason for heating it except to prevent it from chilling the melted asphalt.

X-Q. 27. In preparing mixture, the residuum is heated and the refined asphalt added thereto; at what temperature does this occur?

A. No; the asphalt is melted and the residuum is then added and mixed with it. I have forgotten the boiling point of the asphalt. Residuum is of course in a liquid state or semi-liquid state.

X-Q. 28. When the so-called "asphalt cement" is thus
393 formed, at what temperature is it maintained when the hot sand is admixed?

A. The mixture itself as I have tested it after the sand is added will run as high as 250 degrees. I believe the usual regulations of contractors require that it shall be brought to and dumped on the pavement at not less than 300 degrees. If the temperature is reduced much below this it becomes hard and solid before spreading and cannot be raked or spread by means of rakes and other tools used.

X-Q. 29. When this asphalt cement is heated in readiness to receive the sand addition, what is the consistency of such mixture?

A. About that of West India molasses. That is about as good a comparison as I can make. It is not so fluid as heavy oil, but will run freely when hot.

X-Q. 30. The "refined asphalt" which is used as an ingredient of these pavement mixtures; what is this?

A. It has been derived from different sources. For the best pavements in the United States, asphalt from the Island of Trinidad is used and after being heated to permit the settling of the impurities is poured into barrels and becomes so hard that it will retain its shape after the staves are knocked from the barrels, although it will soften under heat during warm days and finally spread in a layer of four of five inches on any flat surface.

X-Q. 31. How does this refined asphalt differ, if at all, chemically, from "glance pitch" or "mineral bitumen"?

A. I am not sufficient of a chemist to testify on that point, but I can state within my own knowledge that a very large
394 number of bituminous substances which to the eye and ordinary physical tests seem to be practically the same as Trinidad asphalt, are utterly unsuitable as a substitute therefor in the making of asphalt pavements. Generally speaking, when I have had these articles tested, I have been informed that the proportion of bitumen was insufficient. While I have seen such tests made, I am not sufficient of a chemist to point out the differences or their chemical effects.

Noon recess.

X-Q. 32. About what per cent. of bitumen is present in refined Trinidad asphalt?

A. I have never gone carefully into the chemistry of asphalt so as to be able to answer this question. I have had various analyses of asphalt made and reports made to me as to the amount of bitumen, but I have forgotten the proportions.

X-Q. 34. Do you know the relative proportions of the asphaltine and petroline present in the bitumen contents of such refined asphalt?

A. I can I think fully inform you as to the use of asphalt in making pavements, but I am not a chemist and do not know anything about the various chemical constituents of these substances.

X-Q. 35. Aside from the Trinidad variety, what other forms of refined asphalt have you had occasion to consider in connection with their use as an ingredient of asphalt mixtures for pavements?

A. The Trindad is used almost exclusively for the best class of pavements. The asphalt first used in the United States for laying pavements was brought from Virginia and used under the

names of Grahamite and Ritchie asphalt, being taken from Ritchie County, Virginia. It proved however to be simply a pocket
395 which soon became exhausted. Of late years, some asphalts have been brought from California, and one or two western states, but so far as I have information on the subject, they are not equal to the Trinidad asphalt in making a durable pavement. I do not know of any others being actually used, although constant experiments are being made with bituminous deposits from different places.

X-Q. 36. Your practical knowledge of refined asphalt as used for pavements extends to what varieties thereof?

A. The only refined asphalt which I have had any personal experience with has been the Trinidad asphalt.

X-Q. 37. I believe there is upon the market a variety known as Bermudez asphalt. If the pavement mixture contained the Bermudez in lieu of the Trinidad asphalt as an ingredient thereof, is it your opinion that the repair of any such pavement according to the method set forth by Perkins patent 501,537 would be an invasion of said patent?

A. I understand that the Perkins process involves in the first instance the heating of the pavement to reduce it to a plastic or molten condition, and secondly an agitation of the plati plastic portion of the pavement. By agitation I understand to be meant something more than mere scratching. The word is a strong one involving the idea of stirring and picking up the plastic material. These steps of the process therefore could be carried out with any pavement the surface part of which under the action of heat and without being burned would be rendered plastic or molten so as to be agitated and I therefore am of opinion that providing the pavement has these charcteristics it is otherwise immaterial what the composition thereof may be.
396 Therefore if asphalt from any other locality could be used in a mixture that would soften at the surface without burning under the effects of surface heat, the use of the structure described in the Perkins patent on such pavement would embody the operation called for in the claims thereof.

X-Q. 38. In the practice of the Perkins method should it transpire that some part of the material were burned at the place of treatment, would such burning avoid the Perkins method?

A. It would not. Occasionally this would result from the carelessness of the men, but Perkins was, I believe, the first one to disclose the fact that it was possible to direct a strong blast of hot gases onto the surface of an asphalt mixture pavement without

materially burning the same or affecting the part below the heated portion. It is a fact that the burning only takes place if the heating is carried to an unusual extent. The heat seems to form a very thin surface crust which prevents the burning of the asphalt below.

X-Q. 39. What information have you as to the sort of material employed for asphalt pavements on the continent of Europe?

A. I have read a good deal on this subject and have talked with those who have examined into the matter a great deal, engineers and others, who have made such work a specialty and to the best of my knowledge and belief, practically all the continental pavements are laid with rock asphalt either in the form of compressed asphalt, some times compressed cold, or of a mastic, consisting of rock asphalt with an admixture of an oil derived from the dis-
397 tillation of bituminous matters. If there are any others in practical use, I am not aware of it. I say in practical use because foreign Letters Patent contain prescriptions of almost every conceivable character for asphalt pavements.

X-Q. 40. As I understand your testimony-in-chief, you desire to draw a sharp distinction between the "asphalt mixture" pavements such as are used here in the United States and the "compressed rock asphalt" pavements such as are used in Europe; am I correct?

A. Yes; I do draw a sharp distinction because I understand that to embody a process, there must be substantially the same operations upon the same materials to get practically the same result, and in making a comparison I do not consider the materials to be substantially the same when the effects of the operations are so radically different, as I have pointed out, as they are in treating these two different materials.

X-Q. 41. If the method defined by Perkins patent 501,537 were employed for the repair of "compressed rock asphalt" pavements, would such procedure be an invasion of said patent?

A. It would not, because the steps specified in the Perkins patent consisting in heating the material and rendering it plastic or molten and then agitating it so that the added material would mix along the line of union could not be carried out with the rock asphalt or compressed asphalt pavements. After the rock asphalt pavement is heated and the part decrepitated or disintegrated is removed, there can absolutly be no agitation of the part below or admixture of the old and the new portions.

X-Q. 42. I suppose you will agree that a pavement made
398 from compressed rock asphalt is an "asphalt" pavement.

A. Yes. I would apply this term in a general way to any pavement containing asphalt as a main ingredient.

X-Q. 43. In which view, I presume you would include the U. S. pavements containing refined Trinidad asphalt as being also within the category of "asphalt" pavements?

A. Those are the pavements which are generally designated "asphalt pavements." While all pavements containing a large proportion of asphalt may be properly termed "asphalt pavements," it is not customary among those skilled in the art to so refer to them. When a rock asphalt pavement is referred to, it is almost invariably called "a Seyssel pavement" in this country. In such publications as I have seen abroad, these pavements are almost invariably termed "compressed asphalt pavements" or "mastics."

X-Q. 44. What, if anything, do you find in the Perkins patent 501,537, which shows that the method there set forth is restricted to "asphalt mixture" pavements and does not include "compressed rock asphalt" pavements?

A. The statement that the pavement is to be heated until it is in a pliable state and the particles melted and that it is to be reduced to a soft pliable state in which it is "originally laid." These are the characteristics only of an asphalt mixture pavement. A rock asphalt pavement is not originally laid in a soft pliable state, but is in the form of a powder and it is never melted or in any state which approximates a melted condition. It is always a powder, hot or cold, when not compressed, and when it is com-
399 pressed, it is always hard and not soft or pliable.

X-Q. 45. I believe you have stated that rock asphalt consists of about 90 per cent. limestone and ten per cent. bitumen, speaking generally. When that rock is heated barely sufficient to make it fall in powder, can the material be rendered coherent by compression while it is still hot?

A. Rock asphalt can always be made to cohere by compression whether hot or cold. Providing no moisture is present, I am of opinion that it coheres much better and forms a more solid and durable paving material if it is compressed cold than if it is compressed in a heated state, because the heat tends to render it friable so as to break up very easily.

X-Q. 46. In European practice, what is the general mode of procedure, is the Asphalt powdered and compressed while it is cold?

A. Both modes are used; generally it is brought in a heated state and compressed while in this state. My own conviction is that notwithstanding the statements in some of the articles which have been introduced into this case that provided the asphalt is a perfectly dry powder it will form a better pavement if compressed

cold, and that the only reason why the heating has been resorted to has been the failures which have resulted from compressing cold asphalt in a damp condition.

X-Q. 47. In European practice, when a pavement is laid with rock asphalt mastic, is the mastic applied hot or cold?

A. The mastic consists of a composition of powdered rock asphalt and the oil resulting from the distillation of bitumen
400 and is always heated. This is only used for sidewalks and driveways where it is subjected to but little wear.

X-Q. 48. As such mastic is laid, is the composition in the form of a powder?

A. Yes, because the great proportion of it is rock asphalt and the amount of oily matter introduced is never sufficiently great to change its characteristics.

X-Q. 49. At page 12 of Defendants' Exhibit "Beckwith Article," there is a sub-title, viz: "Mastic of Asphalt." Under such title at page 13, I find that "mastic" proper consists of about 330 pounds of bitumen melted and united with about 4,400 pounds of the powdered asphalt; the mastic is drawn off into molds to cool and form solid blocks. At page 13, it appears further that the sidewalk compound is made up as follows, viz:

Ingredients.	Lbs.
Mastic	100
Additional bitumen	5 - 6
Fine gravel	60 - 70

The additional bitumen is first liquefied, the mastic thrown in portion-wise; subsequently gravel is thoroughly admixed or clean dry sand. At page 14, it is said that

"the mastic being of the consistency and brought hot from a portable boiler in an iron ladle (see plate 11, Fig. 16) is dumped on the ground in small charges between the rods and is immediately spread over the surface with wooden plows. (See plate 111, Figs. 14, 15.)"

Would the repair of such a pavement according to the method defined by the Perkins patent 501,537 be an invasion thereof?

401 A. In my opinion it would not for the reason that the large proportion of the pavement consists of the limestone constituents of the rock asphalt. The effect of the heat upon the limestone impregnated with bitumen is to dry and split and decrepitate it, preventing any such series of operations in repair as is described in the Perkins patent.

I regard the only difference between compressed asphalt and mastic to be the presence of a compartively slight addition of bitumen which somewhat softens the same without altering its

general characteristics. Being laid very thin as a general thing because not intended to support heavy weights and for the sake of economy, it would be apt to crack and break if it was as hard as the natural compressed asphalt.

X-Q. 50 Did you ever actually observe the effect of heat, such as the careful practice of the Perkins method would require, upon mastic pavements, having a rock asphalt as an ingredient thereof after the general formula set forth by my last question?

A. No; and I have never heard of its being proposed to make any kind of surface repairs to mastic pavements. These are very thin cheap pavements and when repairs are necessary, as a general thing, the cheapest and best course is to knock off the entire top and put down new. Such pavements generally disintegrate over the whole surface, the bituminous matter evaporating and leaving the surface in a sandy or roughened condition, like very coarse sand-paper.

X-Q. 51. I observe that when rock asphalt is heated, it is said to constitute a powder, whereas when mastic is heated, the 402 Beckwith article says, it has a mortar-like consistency, if a rock asphalt and a mastic of asphalt pavement respectively, were re-heated according to the Perkins procedure, in your opinion, would one become a powder, and the other a mortar-like mass?

A. The reference to bituminous sidewalks on page 13 of Beckwith's article is to a special composition, of which what I have termed "mastic" forms one of the ingredients. To this mastic, it is stated that additional bitumen and fine gravel are added. The mastic itself, which, it is specified, would constitute 100 pounds is the material which I have before referred to as consisting of rock asphalt with a slight addition of bitumen not materially altering its characteristics. Now, I do not recognize that additional bitumen and gravel making a mixture in which there is but 5 pounds of bitumen to 60 pounds of gravel would convert this mastic into anything having the consistency of ordinary mortar. It is of course extremely difficult to define the consistency of one substance by that of another and a certain amount of latitude must be allowed, but the fact that reference is made to the material being "dumped on the ground" shows that the said material is approximately, even with the addition of the bitumen, in a granular condition. If such a material as is described on pages 13 and 14 of the Beckwith article was re-heated according to the Perkins method, I am of opinion that the effect of the direct application of the gases would be to decrepitate the limestone constituting the main body of the material. I may perhaps anticipate

a subsequent question if I state that if the particular ingredients specified in the Beckwith article pages 13 and 14 constituted a pavement which would soften and become pasty under the application of heat as proposed by Perkins, then in that case, the
403 Perkins method might be employed in making the repairs. In such case, however, I would not find that the materials and structures operated upon would correspond with those prescribed in the Crochet patent and the operations would not embody the method prescribed in the Crochet patent, which does not propose to operate upon such a mastic but upon compressed asphalt.

X-Q. 52. When rock asphalt powder is compressed, what causes the particles to cohere?

A. I don't know. I am aware that the same result takes place if particles of lead or gold free from oxide or moisture are compressed. Why they adhere I am not able to explain.

X-Q. 53. In your opinion, is there any difference between the cohesion of such particles under compression and the cohesion of the particles of simple marble or amorphous limestone?

A. In a rock asphalt compressed pavement there are undoubtedly small particles of lime surrounded by films of bituminous matter separated by the bituminous matter, and it is the adhesion of the particles of bituminous matter which causes the body to remain firm and solid. In the case of marble, there is a crystalline structure. Why the parts thereof adhere I don't know, and no more do I know why the parts of the bitumen adhere in the rock asphalt pavement. Of course I recognize that this adherence comes under the term "cohesion" but I do not recognize that the use of the term explains the fact.

X-Q. 54. Suppose you had in powdered form (a) rock asphalt (b) marble, and (c) amorphous limestone, as separate samples. Let each of these samples be compressed in a die as you explained
404 in your direct testimony. In your opinion would there be substantially the same cohesion observable for each sample?

A. I am not sure as to the amorphous limestone. The marble block could be and has been so compressed in a die and its shape altered rendering it more dense and compact, just as the powdered asphalt has been compacted. Where there is a crystalline structure, of course, the pressure would have to be very much more gradual than where there was not. Then again, the bituminous elements of the rock asphalt have in themselves what are termed "adhesive characteristics" and as a consequence, the particles under pressure will cohere when the particles of another powder not having such characteristics would not adhere. Bearing these facts in mind, I could not say that the three different substances would

have substantially the same cohesion; yet it is very difficult to say and I do not know of any one who can say just what the cohesion is in either case, and without this knowledge it is difficult to make a comparison.

Adjourned to Saturday, Feb. 26, 1898, at 10:30 a. m.

Washington, D. C., Feb. 26, 1898, 10:30 a. m.

Met pursuant to adjournment.

Parties present as before.

Mr. Foster's testimnoy continued.

X-Q. 55. By a microscopic examination, did you ever observe the relation which bitumen bears to the lime in rock asphalt powder?

A. I have never made any microscopic observations beyond those to be obtained by the used of an ordinary magnifving glass in connection with the substances of asphalt pavements.

405 X-Q. 56. In Defendants' Exhibit "Malo Article No. 1" page 13 of the t-w. translation, Mr. Malo speaks of an early scheme by Darcy for street paving, consisting "in the employ-" ment of asphaltic rock laid cold." Malo then proceeds to say, " Rock asphalt heated, pulverized by decrepitation laid down over " the body of the street, tamped and compressed by rollers, re-" sumes on cooling the state in which it is found in its deposits; " this it is which produces its strength, its elasticity, its homoge-" neity, its solidarity."

There have been entered on defendants' behalf a number of typical articles from the leading writers on this subject of rock asphalt pavements. If you have any printed description by persons of recognized authority in which it appears that compressed rock asphalt has been laid cold on the pavements of Europe even to the extent of one per cent. of the total surface, I now request you to refer me to these authorities.

A. There is quite a number of authorities showing that the use of rock asphalt for pavements and roadways originated from observation of the fact that particles of rock asphalt that had been dumped in transportation from mines and crushed by successive vehicles formed a solid substantial roadway. This is stated on page 8 of Defendant' Exhibit Beckwith Article. It is also stated in substance in various other publications which I have read, but of which I have no copies here present. Following these indications, different parties at different times have laid the material cold. Reference is made to this on typewritten page 13 of translation of Defendants' Exhibit Malo Article No. 1, where it is

stated that Mr. Darcy, a competent engineer, advocated this method of laying. I do not believe that I can find any state-
406 ment to the effect that even one per cent. of the rock asphalt pavements are laid cold and in fact do not believe that even this amount are so laid, not because the cold compression is inferior to the hot compression, but because it is absolutely necessary to exclude every particle of moisture in order to insure the solidity of the pavement after it is laid and heat is almost an essential means of securing the requisite absence of moisture. In the ordinary well known means of laying therefore, the heating is almost an essential element. If means however could be devised of securing perfect freedom from moisture, I am convinced that cold laying would be much superior to hot laying, and I believe that Mr. Darcy was generally correct in the view he entertained on this point.

X-Q. 57. I have here a French pamphlet entitled "Address Given at the National Conservatory of Arts and Trades in Paris, the 14th of November, 1880, upon: 'Asphalt, its Geologic Origin, its Preparation, its Applications,' by Mr. Leon Malo, Civil Engineer, Graduate of the Central School, Paris, Patent Print and Lithography, A. Michels, 8 and 10 Caire Passage, 1880."

In that pamphlet, as well as in his prior article No. 1 here in evidence, Malo appropriates the word "asphalt" as signifying exclusively a rock formed of pure carbonate of lime and of bitumen. At page 6 of pamphlet, Malo proceeds thus—

"I have said that asphalt is a soft limestone, naturally and intimately impregnated with bitumen. In fact, if a specimen of asphaltic rock be examined by the microscope, we remark that each of its grains is endowed with a slight pellicle of pure bitumen by means whereof it glues itself to the grains surrounding. It follows that rock asphalt is in reality none other than a species of conglomerate, very fine of grain, cemented by bitumen.

407 If we take a bit of this rock and heat it to a temperature of 80 degrees to 100 degrees, this pellicle of bitumen softens, flows, and the cohesion of the asphalt disappears. Each lime grain being separated mechanically from the others, the material falls into powder.

Take this powder while hot, or better, reheat it after it becomes cold, then compress in manner to collect and energetically squeeze the particles one against the other (we proceed to make this experiment under the press there) these are brought together and when the material is again cold, the rock is reconstituted exactly as it was in its primitive state, with the same consistence and the same aspect.

Upon this singular property is founded the compressed asphalt street industry about which I am presently to speak."

Have you any criticism to make upon the correctness of the statement quoted from the pamphlet?

A. I would like your question to be a little more explicit as to what particular statement is referred to. If your question has reference to the propriety of applying the term asphalt to calcareous rock impregnated with bitumen, I do criticize it. That use of the term was a sort of a fad with Malo. It was adopted by him but so far as I am aware, not generally followed, and certainly is not usual with writers with which I am familiar. On the face of it, to apply the term "asphalt" to a block of Val-de-Travers rock consisting of 85 per cent. of carbonate of lime and the same term to a block of bituminous matter, such as is found at the Red Sea or Trinidad Lake and consisting to the extent of 50 or 60 per cent. probably of bitumen, is to my mind an absurdity. Malo's article No. 1, page 72, shows that Malo adopted this term "asphalt" following the usage of the miners, and proposed to employ it in the literature of the subject as practically a term 408 of his own creation in this connection. If your question referred to other statements in the article I have misapprehended it.

X-Q. 58. My question designs to call out your opinion upon the following facts stated by Malo, viz: 1. That each of the grains of asphaltic limestone rock is coated with a slight pellicle of pure bitumen, (2) that on heating said rock to 80-100 degrees the pellicle of bitumen softens and the cohesion of the lime grain disappears; (3) that on re-heating and compressing the lime particles, the rock is reconstituted as in its primitive state; (4) that upon such singular property the compressed asphalt street industry is founded. Please deal with these several topics.

A. As I understand the statements, my experience agrees with them all except that I do not recognize that the rock after heating above a limited extent is reconstituted in its primitive state. I do not think that a temperature of from 180 to 212 Fahr. or 80 to 100 Cent. would be sufficient to make a material difference and to this extent I agree with the statement quoted, but at the higher temperature to which rock asphalt is generally subjected in laying, I believe the heat is prejudicial to a perfect reconstruction. These high temperatures are necessary because the asphalt is expected to retain its heat during transportation so as not to cool before being dumped or chilled too readily when dumped and therefore a high initial heat is considered necessary. As I have tested it by a thermometer in the carts or heaters, I have found it as high as 300 degrees Fahr.

X-Q. 59. In the "Transactions of the American Institute of Mining Engineers, Vol. XVII, New York City, 1889" at pp. 355-375, there is an article read at the Buffalo meeting, October, 1888, by F. V. Greene, New York City, entitled "Asphalt and its Uses." I proceed to give some extracts from such article—although you are free to refer to the full article itself—which reads thus:

"This paper is based on my experience in the use of asphalt, for paving and other purposes, during the last ten years, part of the time as government engineer, in charge of such work in Washington, and part of the time as the managing officer of a corporation engaged in laying such pavements in a large number of cities."

* * * "Mr. Leon Malo, the well known engineer of the Seyssel mines of France, ignoring the Greek lexicon, and the meaning which has attached to the word for over twenty centuries, has sought to appropriate for the mines of his company the exclusive ownership of the word "asphalte," and claims that this word describes only a bituminous limestone." * * *

(P. 360.) "*Bituminous Limestones.*—The bituminous limestones of France have furnished the material with which portions of the streets of Paris and other European cities are paved. The best mines are those of Seyssel and Val-de-Travers. They are of uniform quality, and yield on analysis about 10 to 11 per cent. of bitumen, the rest being pure carbonate of lime, free from clay or other impurities." * * * "It was introduced in Paris about thirty years ago, and has proved a durable material, with the qualities pertaining to a smooth pavement. The chief objection to it is its slipperiness. The limestone, which forms nearly 90 per cent. of its volume, is not granular, but morphous, and it polishes under traffic, so as to become at times dangerous for horses."

(P. 362.) "*Trinidad Asphalt.*—The asphalt of Trinidad is found in a so-called 'lake,' situated about 100 feet above the sea, and about 3 miles from the shore of the island, at the village of La Brea (the Spanish word for pitch). Its area is about 114 acres; its depth, as far as ascertained by certain rude borings, is reported to be about 18 feet at the sides and 78 feet in the center, and underlying it there is said to be a bed of blue clay. If these figures are correct, the lake contains about 6,000,000 tons of asphalt." * * * "The

crude asphalt has the following properties: Specific gravity, 1.28; hardness at 70 degrees F., 2.5 to 3 in Dana's scale; color, chocolate brown. It yields on partial analysis:

Bitumen	39.83 per cent.
Earthy matter	33.99 per cent.
Vegetable matter	9.31 per cent.
Water	16.87 per cent.
	100.00 per cent.

The earthy matter consists mostly of clay, and the rest is very fine sand. The refined asphalt has the following properties: Specific gravity, 1.49; hardness at 70 degrees F., 2.5; color, black. It breaks with a conchoidal fracture, burns with a yellowish-white flame, and in burning emits an empyreumatic odor. It yields on partial analysis:

Bitumen (by CS_2)	59.86 per cent.
Earthy matter	35.82 per cent.
Vegetable matter	4.32 per cent.
	100.00 per cent.

* * * (P. 367.) "The city of Buffalo has now the distinction of possessing more asphalt pavements than any city in the world, though the combined area of the asphalt and the tar pavements in Washington is still greater by about 50 per cent. The area of asphalt here is 1,000,248 square yards, extending over a length of 51 miles, more than the combined area of all the asphalt roadways in Europe." * *

(P. 371.) I have referred to the granular surface of the Trinidad asphalt pavement. The importance of this is very great in affording a foothold to horses and diminishing the slipperiness which any uniform surface must have to a greater or less degree. By passing the finger over two samples, one of the natural bituminous limestone (or French asphalt) pavement and the other of the artificial bituminous sandstone (or Trinidad asphalt) pavement, the difference is very noticeable.
411 It is the difference between fine sandpaper and polished marble."

* * * (Page 373.) Discussion.

"W. H. Delano, London (condensed from a communication to the secretary): Capt. Greene says that asphalt is a synonym for native bitumen. It may have been so at the time Noah's ark was built, precision in technical terms being then comparatively unnecessary, but Mr. Malo's nomenclature is

now generally received. It has no disadvantage, technical or scientific, and to change it for the behoof of the United States alone would be inconvenient. It was in France that the natural produce of fine-grained limestone impregnated with pure native bitumen, called by Malo Seyssel asphalt, was first used—in a liquid form for footpaths—long before Malo's time."

* * * (Page 374.) "The nomenclature is, and has been for five and twenty years, as follows:

1. *Asphalt rock*, for Oolite limestone naturally impregnated with bitumen.
2. *Compressed asphalt*, used for roadways.
3. *Asphalt mastic*, for the blocks (as sold in the trade.)
4. *Gritted asphalt-mastic*, for footpaths.
5. *Refined bitumen*, for mineral pitch from Trinidad or elsewhere.

Of late years people have tried to find a substitute for compressed asphalt in an artificial compound of Trinidad pitch, fine sand and powdered limestone, the most successful form being "Grahamite" or Barber's asphalt, so-called. This should be called Barber's bituminous compound. It has several congeners in Europe; for instance the production of Dietrich of Berlin and Farrington of Paris, etc., none of which have made any way on the continent." * * * "Some 7800 square meters (9729 square yards) of Barber's compound were laid in the Rue de Rivoli, Paris, in October, 1886. Not a square inch of it remains; it was relaid about four times, but could not resist the traffic. The result in Berlin is the same." * * * "Captain Greene (communication to the secretary): As to my definition of asphalt, to which Mr. Delano
412 objects, I beg leave to refer to the Encyclopedia Britannica, Appleton's American Cyclopaedia, Chamber's Cyclopaedia, the Imperial Dictionary, Worchester's Dictionary, Watt's Dictionary of Chemistry, Ure's Dictionary of Arts, Brande & Cox's Dictionary of Arts, Rumpf and Mothe's Dictionnaire Technologique, Larouse's Dictionnaire Universel, Boussignault's Annales de Chimie, Dana's Mineralogy and Geology, and all other standard authorities, each and every one of which says practically the same thing, defining asphalt to be 'native bitumen,' 'mineral pitch,' 'solid bitumen,' 'a compact kind of bitumen,' 'le bitume solide c'est le veritable asphalte,' or other synonymous words, and each of which also cites the Trinidad 'lake' as the principal known deposit of *asphalt*.

Against these authorities stand alone Mr. Malo, Mr. De-

lano, and a few others interested with them in the Seyssel mines, telling us that asphalt means a certain kind of limestone containing a certain specified amount of bitumen. This is not vindicating scientific accuracy; it is merely fighting for a trade-mark. In the definitions of the preceding paper, I have naturally followed the standard authorities.

As to the relative durability of pavements made from bituminous limestones and those made from Trinidad asphalt, whatever the experience may have been in Europe, experience in America shows that the latter are more durable. The pavements made from bituminous limestone (Neufchatel rock), which were laid on portions of Fifth avenue and Liberty street, in New York, wore out after a few years, and have been replaced with Trinidad asphalt pavement. Plans are now being made for a similar replacement during the present season of the Neufchatel asphalt rock pavement on Pennsylvania avenue in Washington. These comprise nearly, if not all, the samples of such pavements laid on roadways, in the United States."

In view of the foregoing extracts, do you agree with Capt. Greene (a) that the Trinidad asphalt compound for paving purposes is as much entitled to be termed "asphalt" as if it were
413 the natural rock variety to which Malo had applied the name "asphalt"; (b) that the composition of crude and of refined Trinidad asphalt is substantially as stated by Capt. Greene; (c) that as Delano asserts the Barber's Trinidad bituminous compound has proven unsuccessful in Paris and Berlin; and (d) as Capt. Greene asserts that the Neufchatel rock pavements laid in New York and Washington soon wore out and have been replaced by Trinidad asphalt pavements?

Mr. Pierce:

Before the witness proceeds to answer, I desire to offer in evidence a photolithographic copy of the full article from the Transactions of "The Minings Engineers," as specified at the outset; such article may now be treated as in evidence, the same being marked "Defendants' Exhibit Greene Article."

A. Referring to your several questions, I have to say (a) that the foregoing extracts show that at the time indicated there was an attempt to designate by the term "asphalt" not only native bituminous matters free from calcareous ingredients, but also limestone impregnated with asphalt. This was in 1888, and I think I am correct in stating that notwithstanding this "fighting for a trade-mark," as it is termed in the extract, it was not common for the writers before then or since to use the term "asphalt"

alone in speaking of impregnated calcareous or sand rocks. Reading Col. Greene's article as it stands, if the term "asphalt" was substituted for the terms "bituminous sandstone," "bituminous rock," "rock," "bituminous limestones" where they occur, the article would be simply unintelligible. Wherever Col. Greene in that article desires to refer to a rock asphalt he calls it either a bituminous rock or otherwise designates it than by the term
414 "asphalt." Where he uses the term "asphalt," he does not mean a rock asphalt. (b) I have no reason to question the statements of Col. Greene as to the composition of crude and refined Trinidad asphalt, although I note that these technical statements are not given upon his own authority but from analyses made by Prof. Bowen. I would state here that when I have had occasions to consult Col. Greene upon these technical details of the characteristics of materials used in pavements (and such questions have frequently come up in various discussion regarding different matters), Prof. Bowen, or Mr. Richardson, or Mr. Howard have been called in as experts to determine the matter. (c) As regards the statement of Mr. Delano, page 374, I of course do not know what the Barber compound was that was used in Paris in 1886, nor how it was laid. I know of no material difference between the Barber compositions of 1886 and those laid within the last three or four years, and I have had occasion to investigate the characters of the compositions running from 1876 to the present time, and I know of no reason why the Barber composition properly laid in 1886 should not have stood all the wear incident to its use; and I cannot but feel that the result was due to imperfections in the mixing or laying and not to the composition, just as I am convinced that the asphalt rock pavements which were laid cold did not fail because of the absence of heat, but from the presence of moisture. It is within my knowledge that preparations are to-day being made to lay the Barber asphalt as substantially the same composition that was used in 1886, not only in Paris, but throughout Europe. (d) I agree with his statement
415 based upon information that I have had from time to time that the Neufchatel or Seyssel or rock asphalt pavements are not so effective as those made from asphalt mixtures. They are difficult and more expensive to repair when disintegration begins, they break up more rapidly, and as I have found by testing the different substances, they can be polished like marble or metal by wear under conditions where an asphalt mixture pavement acquires no polish whatever.

As regards the use of the term "asphalt," I call attention to the statement, page 373, that against various authorities cited stand

alone Mr. Malo, Mr. Delano and a few others interested in the Seyssel mines, telling us that *asphalt* means a certain kind of limestone containing a certain specified amount of bitumen.

The reference to Col. Greene's article renders it necessary for me to draw a distinction which did not at first seem to be material, and the importance of which did not impress itself upon me in my former testimony between pavement mastic and sidewalk mastic. As stated in Defendants' Exhibit Beckwith Article, page 5, the asphalts used in Paris consist chiefly in two different forms, the first for the streets, of the natural rock unalloyed, and the second, the mixture of asphalt and bitumen and fine gravel for sidewalks. In making the sidewalk mixture or mastic, different rock asphalts were used, and these different rocks contained bitumen in different proportions, and sometimes the addition of the eight or ten per cent. of bitumen to the material making the composition would, it is evident, where the rock was rich in asphalt, produce a mixture, which, when heated, would be of a pasty condition, rather than powdery or granular in character. All such mixtures, whether granular or pasty, as actually used, were not used for *pavements* where they would be subjected to vehicle traffic; and when
416 used, were applied only to the depth of from one-half to three-quarters of an inch as a simple facing material upon the foundation. These, however, it must be understood are mixtures embodying additional bitumen sufficient to impart the plastic condition when heated and do not come under the term "mastic." That is, they are mixtures consisting of "mastic" and added material. The mastic itself, as I have before defined, and as sometimes employed, consists solely of a rock asphalt combined with a small proportion of bitumen, rendering it less liable to crack when cold or toughened; but the mastic *composition* alluded to in these extracts has an additional quantity of bitumen, and I know of nothing which shows that these were ever used, except as thin coatings for sidewalks. They certainly were never employed for paving roadways.

Mr. Peirce.

I have here the Patent Office library copy of Defendants' Exhibit "Perkins British Patent." My information is that patents of like subject-matter were procured by Mr. Perkins about July, 1893, not only in Great Britain, but also in France, Canada, and perhaps some other countries. Am I correct as to this?

Mr. Omohundro.

The information of counsel for defendants is substantially correct. There are probably some variations in the mode of

expression or description in the different patents which I cannot now point out, but I do know that Letters Patent were taken out for the Perkins invention disclosed in the British Letters Patent referred to in the countries mentioned
417 by counsel for defendants and in several other countries that I do not now recall.

Mr. Peirce.

Do you mean several other European countries?

Mr. Omohundro.

Yes; several other European countries and I think probably Australia, and some other foreign countries. As the attorneys for Perkins, we took out several sets of patents for Perkins' several inventions, the first set comprising the Perkins method here in suit, and the first Perkins apparatus, in all countries where the joining of the method and apparatus in a single patent was permissible and legally proper, as was done in the British patent referred to.

X-Q. 60. When a limestone rock asphalt pavement is heated slightly—before falling into powder—do I understand you to say that in such condition it is not soft and easily penetrable?

A. I did not make any such statement. Such pavements will become soft even under the heat of the sun in hot summer days and more easily penetrated than when cold.

X-Q. 61. In Mr. Leon Malo's address before the National Conservatory of Arts and Trades, referred to by me this a. m., the author speaks at page 24 of pamphlet as follows:

"Thus, I have seen lately used upon the streets of Paris to dissipate the 'maccaroons' a remedy which I had advised some years ago for the repair of spots, that is to say which I designed for suppressing the slight depression of the asphaltic crust which, by rain, filled with water and formed reservoirs
418 under the foot of the passer-by. The process described by me in a recent memoir (Bridge and Highway Annals, November, 1879), consists in heating the surface of the asphalt by means of red-hot plates or any other expedient to soften it, then scraping it to a certain depth while it is still hot; finally, throwing upon the location of the spot a supplement of hot powder to combine with it. The two powders being at the same temperature, solder perfectly to each other and the defect disappears."

In view of Malo's statement to the effect that the new and the old powder at the time of union are of the same temperature, and in view of the further fact set forth at page 10 of Defendants' Ex-

hibit "Beckwith Article" in which it is stated concerning these rock asphalt pavements—

> "to resume the work of the previous day, the edge of the solid asphalt must be cleared of dust and loose particles and a layer of hot asphalt thrown upon it to heat it; when the edge is sufficiently heated the layer thus thrown down is removed * * * and as this removal takes place a hot layer from the carts is thrown down and spread, and the packing immediately commenced as before described."

Are you afforded any fuller light respecting the hot or cold temperature of the asphalt pavement when the same is to be repaired by the Crochet method you have considered?

A. Your question proposes a combination of operations which is not suggested in any article or publication that I know of. Your question also assumes some substantial advantage from heating the material in order to consolidate, and I don't recognize any advantage beyond depriving it absolutely of moisture. That is, assuming the parts to be dry, every degree of heat beyond that tends to deprive the material of solidity rather than to cause the
419 parts to adhere and become compact. As regards the process described in Malo's address as quoted, it differs from that of the Crochet patent in that after the pavement is heated, instead of scraping out the spot and then scratching the surface below, the rake is used simply to operate upon the heated portion to reduce it to powder without removing it and then the fresh material is added hot to mix the two powders. I am willing to assume (although it is not stated) that after the powder is added it is compacted. Now I have tried this process myself, heating the pavement sufficiently to cause the upper surface to crumble and then taking a rake and raking up the hot portion until it crumbled into a powder, then adding the fresh material and ramming it down. By this operation, the depression could be filled up and the surface appearance just as in the operation of the Crochet patent did not disclose a patch to any material extent, the depression being plugged up, but there was no greater adhesion between the old and the new parts; but on the contrary there was less than when the old material was raked out. On attempting to cut through the pavement in each case, the block detached itself from the old pavement. I found that after heating the surface, upon applying a rake, it would penetrate to a depth of, say, one-half an inch, when it met a portion of the old material which was too hard to be penetrated and the result was simply to break up a mass of dry powdered stuff upon a substantially solid foundation and surface. I was led to try this experiment because

of some little uncertainty as to whether the Crochet patent explicitly stated that the old material was not to be mixed with the new material, although as I read it, the old material had to be removed and replaced by the new.

420 Defendants' attorney offers in evidence the printed copy of Malo's Address referred to in the course of to-day's testimony, and the same is marked "Defendant's Exhibit Malo Pamphlet."

X-Q. 62. To your view is the Perkins method patent 501,537 equally infringed whether or not any portion of the old material be removed from the spot after heating but before applying a fresh addition?

Question objected to as calling for a construction of the claims sued upon, and the expression of a legal opinion, but counsel for Complainant see no impropriety in the witness stating whether in his opinion such a process as that described by counsel for Defendants in his question is disclosed in the Perkins method patent in suit or would in his opinion fall under the terms of the claims of the said patent as he understands the same.

A. The claims of the Perkins patent in suit do not require that the old material be either removed or retained. I have before pointed out that in operations under the Perkins process with a new pavement where simply a depression had to be filled up the surface is merely softened so that it could be picked up and opened and the new material added. Generally in repairing old pavements, there is dead matter which must be removed, as I have pointed out, and if the pavement has not sunk, it is necessary to rake out sufficient material to allow for the introduction of the fresh material. As I understand the Perkins patent and claims, the process thereof could be carried out whether or not the old material was removed.

Adjourned to 10:30 Monday, Feb. 28, 1898.

421 Washington, D. C., Feb. 28, 1898.

Met pursuant to adjournment.

Parties present as before.

Re-direct by Mr. Omohundro.

R-D-Q. 63. Please state whether or not the mastic preparations, such as are referred to in Defendants' Exhibit Beckwith Article, page 13, were ever used for streets or roadways?

A. So far as I am aware the composition consisting of a mixture of mastic itself composed of rock asphalt and bitumen with additional bitumen and gravel and of a character adapted to be poured and laid with a wooden trowel without compression was never used except for sidewalks and places where there would be but little pressure, and such material was always laid in a very thin coat of approximately one-half inch in thickness. Such material would be utterly unserviceable for use upon roadways, not only because of the fact that articles of any weight would sink into it or crush through it, but also because of the fact that it was not compressed or consolidated so as to resist wear. Even mastic itself consisting of rock asphalt and an extra proportion of bitumen and constituting what were called bituminous pavements or pavements of bitumen was but seldom employed for this purpose, being almost exclusively used for sidewalks and light ways, or ways where there was but little pressure.

R-D-Q. 64. State if you know the proportion of Trinidad asphalt streets in the United States to those made from Bermudez or other than Trinidad asphalt.

A. My personal knowledge only goes to the fact that
422 those made from Trinidad asphalt constitute the greater proportion. On information and belief, as I have heard from time to time, I can say that about 95 per cent. of the pavements laid in the United States are made from Trinidad asphalt.

R-D-Q. 65. Refer to X-Q.'s 47 to 51 and state if you wish to add anything in connection with the matters referred to in said questions and answers thereto?

A. In my answer to X-Q. 47, I wish it to be understood that I am referring as the question calls for, to pavements of mastic and not to mastic compositions, where there is bitumen in addition to that added to the rock asphalt in making the mastic, and I refer to mastic and not the mastic compositions in answer to X-Q. 48. In my remaining replies regarding the composition of the Beckwith article, I have pointed out the difference between mastic and a mastic composition, but I do not wish to be understood in the concluding part of my answer to X-Q. 51 to be considered as stating that such mastic compositions were or could be practically used for a pavement.

R-D-Q. 66. Regardless of the technical meaning of the terms employed, state whether or not the process set forth in the Crochet patent is the same or a different process from that set forth in the Perkins patent in suit?

A. Considering the steps of the Crochet process regardless of the use of any given names for the articles operated upon I find

that as a process it differs from the Perkins process in the effects or results or characteristics of the materials upon a number of points. First, the Crochet patent requires that the old pavement shall be heated until it decrepitates or disintegrates, while the
423 Perkins process requires that the old material shall be heated until it melts without burning. If the Crochet process of heating to disintegration was carried out with an asphalt mixture pavement, the upper material of such pavement would be destroyed and the process would be ineffective. The Crochet patent refers to the action of a rake in striating the face operated upon by the rake. The Perkins process recognizes a molten condition of the material which would not admit of striations. The Perkins process requires that the body of the pavement below the upper surface subjected to the direct action of the heat shall be agitated in order that the fresh material may mix with it, while, as before stated, the Crochet patent requires that the surface of the old material after the removal of the disintegrated portion shall be merely striated or scratched. It does not require that this portion shall be agitated so as to mix with fresh material. The Crochet patent sets forth that the fresh material in a powdered condition shall be applied to and compacted upon a striated surface. The Perkins patent requires that the fresh material in a semi-molten or pasty condition shall be mixed with the surface portion of the old material. I therefore regard the two processes as radically different, the Crochet process consisting merely in the use of heat to facilitate the excavation of a portion of the pavement which is subsequently plugged up, while the Perkins process requires the use of heat for the purpose of softening without disintegrating in order that the softened portion may be agitated and picked up so as to mix with the new material.

R-D-Q. 67. State whether in your opinion in view of the information conveyed in any or all of the various extracts or publications to which you have been referred the exercise of in-
424 vention was required at the date of the application for the Perkins patent to devise the process set forth in said patent?

A. At the date of the application for the Perkins patent, and for many years before, the repairs of asphalt composition pavements had been attended with great delays and expense of labor, tools and materials; and I find that although the information contained in the various articles and publications to which I have been referred was well known among those familiar with the art, this information never appeared to have suggested to any one the practicability even of operating directly upon an asphalt mixture pavement by sufficient heat to soften or melt the same without

burning it to a deleterious extent. Any one at that date familiar with the characteristics of an asphalt mixture pavement and with the effects sometimes produced by fires kindled upon the same would have been deterred by reading such publications, as for instance the Crochet patent or others of a like character, by any suggestion therein as to the application of heat to disintegrate the surface. I further find that notwithsanding the fact that it appears that at different times those skilled in the art suggested the application of heat to the surface of a rock asphalt pavement to facilitate the excavation of the same for repairs, it never seems to have occurred to any of these parties or those familiar with their writing that it would be practicable to apply heat for the purpose of repairing the surface portion only of an asphalt mixture pavement; but on the contrary they went on for years digging out the entire surface portion and plugging up the holes with all the attendant disadvantages of such operations. There
425 is nothing whatever in any of the publications referred to which to my mind suggests the operation of heating, melting or softening and agitating the surface of an asphalt mixture pavement or of any other kind of a pavement so as to open it up and permit the admixture with the opened up portion of a new material in a like softened state; and the fact that those skilled in the art failed to receive any such suggestion from such publications, is evidence to my mind that notwithstanding these publications, invention was required to devise the process finally put into operation by Perkins.

R-D-Q. 68. Please make two sketches, one showing a section of an ordinary asphalt mixture pavement, having a hydraulic cement foundation, a binder course, and a top dressing or layer of asphalt mixture, and the other sketch showing the appearance of the same after the top dressing thereof has been heated and agitated by the Perkins method.

A. I have made the sketches and here produce the same. I have indicated on the sketches the different layers or parts of the pavement.

Counsel for complainant offers in evidence the sketches made by the witness and the same are marked "Complainant's Exhibit Foster Sketch No. 2," and "Complainant's Exhibit Foster Sketch No. 3" respectively.

426 IN THE CIRCUIT COURT OF THE UNITED STATES.

For the Northern District of Illinois, Northern Division.

United States Repair & Guaranty Company
vs.
Assyrian Asphalt Company et al.
Gen. No. 24,534.

STIPULATION.

It is hereby stipulated between counsel that the following depositions taken in a current suit, entitled United States Repair and Guaranty Company and Barber Asphalt Paving Company vs. Standard Paving Company, Northern District of New York, and based upon Perkins method patent No. 501,537, here at issue, be entered of record in this cause, with like force and effect as if each of said depositions had been duly adduced upon examination of the witnesses herein, the depositions being as follows, viz.: Philip W. Henry, Henry J. Warren, Volney W. Foster (2), William H. Dober, Joseph H. Cranford, Henry R. Kasson, Charles H. Burwinkle and Eugene G. Schwendeman.

427 New York, January 20, 1898.

Met pursuant to notice.
Present—Counsel as before.

PHILIP W. HENRY, a witness called on behalf of complainants, being duly sworn, testified in answer to questions by Mr. Edward N. Dickerson, as follows:

1 Q. What is your name, age, residence and occupation?

A. Philip W. Henry; age, thirty-four years; residence, New York; occupation, general manager of the Barber Asphalt Paving Company.

2 Q. How familiar are you, and were you in July, 1893, with the art of repairing asphalt pavements in the United States?

A. At that time I had been in the business for six years, and had experience in four or five different cities personally, and had seen working carried on in other cities on Barber asphalt pavements.

3 Q. For instance, can you name some cities where you had seen such repairs made?

A. Buffalo, N. Y.; St. Joseph, Mo.; Omaha, Neb.; New York City, N. Y.; Chicago, Ill.; Kansas City, Mo.

4 Q. Previous to the Perkins patent, describe generally the method of repair of asphalt pavements in the United States, as you were familiar with it?

A. The method was to mark out a line enclosing the part to be repaired, and cutting through the asphalt down to the hydraulic concrete foundation, then removing all the asphalt surface, that is, the full thickness of the asphalt, then generally painting the joints of the exposed portions of the asphalt, then laying in new material to the same thickness as the old material, and then tamping it, rolling it, and smoothing it in the usual way.

428 5 Q. After the method of surface repair described, when the Perkins patent came into use, will you state how generally it was employed, and to what extent it substituted the old method?

A. As far as the Barber Asphalt Paving Company is concerned, it superseded the old method almost entirely. In fact, for the last three years—that is, '95, '96 and '97—all which years we have kept careful records of the number of square yards laid in each city by the surface heater method, we have laid in the aggregate by the surface heater method, eight hundred and eighty-five thousand square yards of repairs, which I presume is fully three-fourths, if not more, of the total repairs made.

6 Q. Your company is a licensee under the Perkins patent, is it not?

A. Yes.

7 Q. And you understand the process described there?

A. Yes.

8 Q. Are you able to state what saving results by the use of the Perkins method over the old method of repairing per yard?

A. I never made a careful estimate as to the exact amount, but in several cities where we have contracts with the city for the repairs of pavements, in which prices are stated for surface heater work, and also for repairs, where the entire thickness is cut out, the difference in those prices is about fifty cents per square yard in favor of the surface heater method.

9 Q. In these cities, for instance, there is then a saving to the city in the repair work of about fifty cents per square yard?

A. Yes.

10 Q. Are you able to state from any records in your possession

whether this Perkins system is a system approved for repairing pavements by the engineers?

A. It is. At a meeting of the committee on street pavements of the American Society of Municipal Improvements at the
429 annual meeting of that society at Nashville, Tenn., in November, 1897, the committee on paving, recommending in one of their sections as to the method of repairing asphalt pavements, state that the process known as the skimming process may be employed. This refers to the surface heater method. I may state that that society is made up of the city engineers and various other officials of the departments of public works in various cities. The specifications were drawn up by the Chief Engineer of Peoria, Ill., and the Assistant Engineer of Brooklyn. We have used this method, I suppose, in thirty different cities with the approval of the city engineers and others in authority in each of these cities.

Cross-Examination by Mr. Becker:

11 X-Q. Prior to 1893, was new pavement laid as it is now?

A. Yes; as far as the Barber Co. is concerned.

12 X-Q. About how large pieces of new pavement were laid at a time prior to 1893 on a given street?

A. Do you mean in a day?

13 X-Q. No. Squares, if you please, of pavement.

A. In what period of time?

14 X-Q. Through several years prior to 1893?

A. The method was to bring the asphalt hot on the street in carts or wagons, holding anywhere from six to seven thousand pounds, dumping it on the street, and laying it so that two thousand square yards per day were laid, which is about the same average as at the present time.

15 X-Q. There was a basis of concrete cement first laid?

A. Yes; concrete was first laid.

16 X-Q. Then, what was the next step?

A. After the concrete was set, it was swept with brooms, and then if the binder coat was used, the binder was first spread on the concrete.

17 X-Q. What was that made of?

430 A. Of fine broken stone, generally about an inch in diameter, coated with a bituminous paving cement, either asphalt cement or coal tar.

18 X-Q. And in some instances, was that heated?

A. Yes; and also in some cases a cushion was laid in place of it.

19 X-Q. What was that?

A. A cushion practically the same as the top coat; that is, it

was formed of sand and asphalt cement, except there is generally a little more asphalt in the cushion.

20 X-Q. About how large a space would be laid at a time, before you begin to put the asphalt proper on it?

A. They would generally lay for from half a day to a day's work—possibly a thousand square yards.

21 X-Q. At one time?

A. Yes.

22 X-Q. Before you put any asphalt on it?

A. Yes; before the top coat of asphalt.

23 X-Q. Then you say your wagons with hot asphalt would come up?

A. Yes.

24 X-Q. And spread about a wagon load at a time?

A. Yes.

25 X-Q. On a sixty-foot street, how long would that extend?

A. We counted on a wagon load laying about thirty square yards.

26 X-Q. What would that be, taking a street 66 feet in width. How long would that be in linear feet?

A. About four feet.

27 X-Q. So you would have a strip of asphalt laid about five feet along this street, and the width of the street?

A. No; generally on a street of that width, we would have at least three wagons to the width of the street, one wagon on the quarter, another on the center, and another on the other quarter, so that the strip would be about three times as long.

431 28 X-Q. That stuff was all hot?

A. Yes.

29 X-Q. And then, what was the next thing that was done?

A. After the material was dumped, it was shoveled into place so that the layer would be approximately about fifty per cent. thicker than the finished pavement was intended to be, and men with rakes stood there to rake it out to an even grade, and a surface roller—that is, a roller handled by men, usually was run over the material to give it its first compression, and then, after that, some hydraulic cement sprinkled over it and rolled with a ten ton roller, and then it was gone over with smoothing irons and tamping irons; hot irons were used where it was necessary.

30 X-Q. Now, when you came to laying the next strip further along the street that joined on, what did you do then?

A. The rakers went on with the same operation as before.

31 X-Q. What did they rake?

A. The material of the second load, as it came up.

32 X-Q. Did they rake the edges of the first?
A. If it was not exactly to grade they would have to go over that place; naturally the men could not carry the grade of the street along the joint, and so, when the next load was laid, they would have to pull off that joint, or add more material to it.
33 X-Q. What did they do next?
A. Passed the rake over the joint.
34 X-Q. Over the edge of the joint?
A. That would depend on how cold it was.
35 X-Q. Suppose it had cooled?
A. They take off the hot asphalt, and cut off the chilled portion.
36 X-Q. So as to have something left at the edge there that was hot and soft?
432 A. Yes.
37 X-Q. And then the new material that was hot and soft was brought up against it?
Yes.
38 X-Q. Then what was done?
A. The roller went over it, and the joint was smoothed with the smoothing iron, if necessary.
39 X-Q. That smoothing iron was hot?
A. A hot iron: yes.
40 X-Q. Why was the iron hot?
A. The iron was hot for the purpose of not chilling the material.
41 X-Q. Why don't you want to chill the material?
A. The grade would not be perfect.
42 X-Q. Why?
A. There would be a division line between the two.
43 X-Q. You wanted to weld it to keep it hot?
A. Practically.
44 X-Q. That is why you used all these tools that were hot?
A. Yes.
45 X-Q. The rakes were hot as well as the other tools?
A. Yes.
46 X-Q. Everything was kept as hot as possible so as to keep the stuff soft and pliable?
A. Yes.
47 X-Q. So that when the next material was brought up and put on, it would weld with the old?
A. Naturally.
48 X-Q. Otherwise, you would not have had a perfect weld?
A. That is correct.

49 X-Q. When the Perkins process came along, they heated the old material that had become cold, first; didn't they?

A. In laying new pavements?

50 X-Q. No; in repairing.

A. Yes; they heated the old material.

51 X-Q. Heated the old material that was left in the hole?

A. Yes.

52 X-Q. What did they do that for?

433 A. For the purpose of softening it, so it could be scraped off.

53 X-Q. For any other purpose?

A. No.

54 X-Q. Wasn't it made soft according to the very terms of the Perkins patent, so that the new material, being hot, and the old material having been softened by heating, a perfect weld would take place?

A. It was not necessary for the old material to be hot; that is not essential; the new material being placed upon it would heat it up.

55 X-Q. In some way or other, either by heating with some kind of a heater, or by putting very hot new material against the old material, some portion of the old material against which the new material came in contact was heated?

A. It was.

56 X-Q. In practice—was it not the practice, as you understand it under the terms of the Perkins patent, to pass a surface heater over the hole first before the new material was placed in the hole?

A. Not always.

57 X-Q. It was done a good deal, though, wasn't it?

A. No; I think not.

58 X-Q. Do you recognize this clause of the Perkins patent, which I read to you, at lines 75 to 95, as follows: "Now as would "be seen by turning on as many of the burners as are desired a "strong blast of heat is projected against the surface of the as- "phalt and readily melts it. As explained above, when it is de- "sired to repair a spot the apparatus is moved adjacent thereto "with the burners directly above the spot. These soon reduce "the surface asphalt both at the spot and at the surrounding "edges to a pliable state, the strong blast causing not only the "immediate surface, but the particles deep down to be melted "and yet not burned. With a rake or other suitable instrument "the operator then agitates or stirs up the softened material

434 "and by adding new material of substantially the same de-

"gree of softness the spot or depression to be repaired is filled "up and subjected to the usual smoothing and finishing operation "as in the case of a new pavement"?

A. I suppose I have read the patent. I do not know that I recognize it. I have never gone into the patent thoroughly.

59 X-Q. Wasn't that the method which was adopted under the Perkins patent?

A. That does not cover it, as we have carried it out.

60 X-Q. Don't you work under the Perkins patent?

A. That depends on the meaning of that clause. We do not always put on the new material when the other is still hot.

61 X-Q. You do not always do it—you do it sometimes?

A. Sometimes, if it is convenient.

62 X-Q. You do use the surface heater then?

A. We do.

63 X-Q. And have you ever known your company to work under the Perkins patent, so-called, without using the Perkins surface heater since the time of that patent, since your company acquired it?

The question is objected to on the ground that it does not appear what is meant by the Perkins surface heater in the question.

Question withdrawn.

64 X-Q. Didn't your company at the same time that it acquired the license under Patent No. 501,537, of July 18, 1893, acquire, as you understand it, not only the right to make repairs in the methods, generally speaking, described in that patent, but the right to use the surface heater just referred to in the patent?

A. I have always understood so.

65 X-Q. Now, in any question I may ask you hereafter, you may understand that I refer to the Perkins surface heater as described in this patent, which is, in brief, is it not—a gasoline
435 tank with burners underneath, and with wheels, that can be rolled over the spot?

A. Yes.

66 X-Q. In your testimony, you have used the words "surface heater method;" have you not?

A. I have.

67 X-Q. Did you not, in that testimony, refer to the surface heater just mentioned in my previous question?

A. Not necessarily.

68 X-Q. Have you used any other surface heater besides the Perkins surface heater referred to?

A. We have.

69 X-Q. What kind of a one was that?

A. We used experimentally a heater in which coke was the fuel.

70 X-Q. Since you acquired the Perkins patent?

A. Yes.

71 X-Q. Did you abandon the experiment?

A. We did.

72 X-Q. And have you always since then, in connection with the so-called Perkins process in repairing holes in asphalt pavements, used the Perkins surface heater?

A. We have.

73 X-Q. And that is the heater to which you have referred in your testimony, as "the surface heater method"?

A. The great bulk of repairs made under that method has been made with the gasolene heater.

74 X-Q. And that is what you had reference to?

A. I had reference to the general method of softening the top of the pavement and taking it out regardless of the heater used. It was more economical to use gasolene heater.

75 X-Q. You have stated that the surface heater method was more economical, on your direct examination; have you not?

A. Yes.

76 X-Q. What heater did you refer to in that case?

A. The Perkins surface heater; the gasolene heater; and
436 also the other heater—the coke heater—was cheaper than the old method of cutting out.

77 X-Q. This process of heating and leaving some old material in is called "skimming," is it not?

A. It is.

78 X-Q. And it is that distinctive idea of heating with the heater which softens and allows the removal of the old material without chopping it out, which has been permitted or recommended, or adopted, whatever you please to term it, by this municipal body which you mention?

A. Yes.

79 X-Q. You consider it a better method than the old method of chopping out with picks or axes?

A. I do.

80 X-Q. And as more successful, makes a better joint?

A. Yes.

81 X-Q. The reason is that the surface is heated by the heat which is applied?

A. I do not know as to that?

82 X-Q. Well, why is it better? You tell.

A. It is more economical; that is the chief consideration.

83 X-Q. Why is it more economical?

A. You don't have to put back so much of the new material.

84 X-Q. Will you explain that, please?

A. Instead of putting back the full thickness of the pavement, say two and a half inches, it is only necessary to put back half an inch or one inch.

85 X-Q. Why is that necessary?

A. Because, instead of cutting out the full thickness you have only heated the surface and scraped off half an inch or an inch instead of cutting out all of the old material.

86 X-Q. Won't you please reverse that, and say it is because you heat the surface, and are thus enabled to take off a part instead of the whole, that it is more economical?

A. Yes.

437 87 X-Q. Between the old coke heater and this blast of gasolene flame, the gasolene flame does the work cheaper and better, does it not?

A. That is true.

Re-direct Examination by Mr. Dickerson.

88 RD-Q. What is an average day's work of these heaters in repairing pavements—I mean each heater?

A. I should say about forty square yards an hour; or about four hundred square yards an ordinary working day; that depends on how large the amount to be repaired on a given street is.

Recross Examination by Mr. Becker.

89 Re-X-Q. And at the same expense by the old process of repairing, cutting through, which you have described, about how many yards would you do, as compared with the four hundred yards which you have named?

A. At the expense including material?

90 Re-X-Q. The expense including material and work.

A. At the same expense under the old method, I do not suppose we could do over two-thirds as much.

PHILLIP W. HENRY.

HENRY J. WARREN, a witness called on behalf of complainants, testified in answer to questions by Mr. Dickerson, as follows:

Q. 1. What is your name, age, residence and occupation?

A. Henry J. Warren; thirty-six years of age; residence, Buffalo, New York; superintendent of the Barber Asphalt Paving Company, at Buffalo.

Q. 2. And you are familiar with the repair work which has been done in the City of Buffalo by the Barber Asphalt Paving Company?

438 A. I am.

Q. 3. Will you state about how much has been done in Buffalo by the surface repair system, which the last witness has been talking about, since the date of the Perkins patent?

A. Do you mean for the City?

Q. 4. Yes; for the City?

A. About 172,000 square yards in the years 1895, 1896 and 1897.

Q. 5. What has been the saving by that process over the old process of cutting through, per square yard?

A. About fifty cents per square yard.

Q. 6. Since the acquisition of a license under the Perkins patent by the Barber Asphalt Paving Company, you have practically used that method entirely in repairs in Buffalo?

A. Practically: yes.

Cross Examination by Mr. Becker.

X-Q. 7. And by that you mean you have used the Perkins gasolene surface heater, do you not?

A. Yes, sir.

Redirect Examination by Mr. Dickerson.

RD-Q. 8. But, of course, you have only skimmed the surface in the way the last witness has testified, in connection with that system?

A. Yes.

Recross Examination by Mr. Becker.

Re-X-Q. 9. And by system, you mean heater, do you not?

A. Practically, I suppose.

Signature and oath waived.

VOLNEY W. FOSTER, a witness called on behalf of complainants, testified in answer to questions by Mr. Dickerson, as follows:

Q. 1. What is your name, age, residence and occupation?
439 A. Volney W. Foster; residence, Chicago, Illinois; president of the United States Repair and Guaranty Company.
Q. 2. That company is the owner of the Perkins patent here in suit?
A. It is.
Q. 3. And it has granted licenses under that patent?
A. It has.
Q. 4. Will you state, generally speaking, how many such licenses it has granted under which royalties have been paid?
A. Ten or twelve.
Q. 5. And what is the amount of royalty which has been paid?
A. About twenty thousand dollars a year.
Q. 6. How many machines have been licensed to carry out the process of the Perkins patent?
A. About fifty.
Q. 7. And the average time during which those machines have been licensed?
A. That is more difficult. We have no later license than 1895, and most of them were in use in 1894. I could be more definite if it is desirable.
Q. 8. Can you state whether or not the method of the Perkins patent is a method now generally employed in the United States in the repair of asphalt pavements?
A. It is.
Q. 9. And the exceptions, I suppose, are practically very few?
A. Very few.

Cross Examination by Mr. Becker.

X-Q. 10. Have you the licenses with you, or a copy of them?
A. I have them; yes, sir.
X-Q. 11. What patents do they describe?
A. No. 501,536—
X-Q. 12 What is that for?
440 A. The apparatus patent; No. 501,537, the Perkins method patent; and No. 517,191, the second Perkins method patent —the hot air blast.

X-Q. 13 The first patent you have mentioned, generally speaking, describes a gasolene burner apparatus, does it not?

A. I should have to depend on Mr. Omohundro for answer to that. It is substantially the machine shown in the Patent No. 501,537.

X-Q. 14. Patent No. 501,537 is what you call the method patent—the patent in suit here?

A. Yes.

X-Q. 15. What is the other one?

A. The subsequent method patent, No. 517,191, a hot air device.

X-Q. 16. Instead of a flame?

A. Yes.

X-Q. 17. And those are the patents that are covered by these licenses mentioned?

A. Yes.

X-Q. 18. Have you granted a single license for the Perkins method patent, No. 501,537, not accompanied by the other apparatus patents?

A. I think not.

X-Q. 19. So these people who have paid you these royalties have paid gross royalties for the devices as well as the alleged method?

A. Yes.

Redirect Examination by Mr. Dickerson.

RD-Q. 20. They have not used, however, the hot air process about which you have referred?

A. That has never been used practically.

Signature and oath waived.

441 Washington, January 27, 1898, 2 p. m.

Met pursuant to notice.

Present.—Counsel for Complainant as before.

No appearance for Defendant.

WILLIAM H. Lober, a witness produced on behalf of complainant, being first duly sworn, deposes and says, as follows:

Q. 1. What is your name, age, residence and occupation?

A. William H. Lober; age, 43; occupation, general superintendent of the Vulcanite Paving Company, of Philadelphia; residence, Philadelphia.

Q. 2. State how long you have been familiar with laying pavements, and the character of pavements which are laid by the Vulcanite Paving Company?

A. I have been in the business about twelve years. I have been with the Vulcanite Paving Company about two years, and that company puts down any kind of pavement that the contract calls for, including sheet pavements of asphaltic mixtures and rock asphalt.

Q. 3. State if you are familiar with the method of repairing asphaltic mixture pavements known as the Perkins method, and with the apparatus used therefor?

A. I am.

Q. 4. State, if you know, what method of repairing asphalt pavements was used before the Perkins method came in to use?

A. When an asphalt pavement was to be repaired previous to the introduction of the method known as the Perkins method, it was necessary to cut with an axe or cutter made for that purpose completely through the surface down to the hydraulic concrete, cutting a shoulder completely around the defective portion, and removing all of the old material of the pavement. The joint was
then painted with asphalt cement or tar and filled with new
442 material, tamped and rolled into place. This made a plug
which was cemented to the edge, but not to the hydraulic concrete.

Q. 5. State what advantage resulted in this operation from first heating the pavement at the point where the repair was to be made?

A. No advantage, as it was easier to cut a joint on the hard pavement than it would be on pavement that had been softened. It is more difficult to cut out a pavement on a warm day than on a cold one.

Q. 6. What was this character of repair commonly called?

A. Plugging.

Q. 7. What was the effect as regards the tools used?

A. The axes or picks were dulled very quickly and many of them broken. It was necessary to keep a blacksmith employed sharpening axes and cutters.

Q. 8. In operating with the Perkins method, what are the different steps required?

A. With the Perkins method, you first heat the old pavement until it is softened, then remove the slight scale from the surface, rake up the softened material below the surface, and add a sufficient portion of new mixture to bring your pavement to the proper

grade of the street. This is tamped and rolled and forms a perfect bond with the old pavement, resulting in a perfect repair. If there is an interval between the time of the softening and removing the top scale and the adding of the new material, we usually paint around the edges of the old pavement and over the bottom of the hole before adding the new material.

Q. 6. Have you ever heard this operation termed "plugging?"

A. I never have. It is generally called "skimming" or "surface patching."

Q. 10. Have you ever cut across a pavement that has been repaired in the manner last described?

443 A. I have.

Q. 11. State whether or not such transverse cuts indicate any line of separation between the old and new material?

A. They do not. I have always found a perfect bond between the new and the old mixtures, so that the pavement after it is patched is in just the same condition as when it was first laid.

Q. 12. State what tools are necessary to be used in the Perkins method of repair for operating on the pavement?

A. Some method of heating, a hoe for removing the scale, a rake for loosening up the old mixture and the usual asphalt tools for laying a new mixture. A hoe with notched teeth may be used instead of a hoe and a rake.

Q. 13. What is the effect of the hoe or rake upon the material which remains after the scale is removed?

A. It loosens up the old mixtures, so that a bond may be more easily made by mixing the old and the new.

Q. 14. To what depth generally is the pavement softened by the use of the heater?

A. From a half to three-quarters of an inch.

Q. 15. What is the condition of this softened part of the pavement?

A. It is pasty, sticky and glossy, like fresh material.

Q. 16. If the fresh material is added immediately after the old material is raked up, is it or is it not necessary to add the cement over the surface?

A. It is not necessary.

Q. 17. State whether or not you are aware of the general opinion of those skilled in the art of laying asphalt pavements, as to the practicability of the Perkins method at the time it was introduced?

A. I remember very distinctly the opinion among practical men at the time the introduction of the Perkins method was pro-

444 posed. It was considered to be totally impracticable and an absurd method of making a repair, one reason for which was that a sufficient heat to soften the pavement would destroy the virtue of the asphalt cement in the old mixture; also that it would be impossible to construct a heater that could be handled quickly enough for the purpose. I held these opinions myself and heard them expressed by others before I had seen the machine in operation or the process used. After seeing the process I said to Mr. Perkins that he had hit the biggest thing introduced in asphalt work for a long time.

Q. 18. Examine the drawings of the Perkins patent 501,537 in this case, and state whether or not you have ever seen a heater used like that?

A. I have. This is one of the forms of the Perkins heater used in carrying out the Perkins process.

Q. 19. Do you know any of the other forms being used in carrying out the Perkins process?

A. Yes, we have used the coke heater, the Laster heater, and still another form.

Q. 20. Examine the Letters Patent to H. W. Laster, No. 552,913, and state whether or not that represents what you term the Laster heater?

A. It does.

Q. 21. State whether or not the heaters to which you have referred are generally termed Perkins heaters by those using the Perkins process?

A. Yes; with the exception of the coke heater.

Q. 22. State whether or not your company is licensed under both the process and the apparatus Perkins patents?

A. We are, but we do not use the apparatus shown in the Perkins drawings.

Q. 23. State what royalty or payment vour company makes under the license under the Perkins patent?

A. We pay $2,000 per year.

Q. 24. And do you make that payment whether you use 445 the heater described in the Perkins patent or some other heater?

A. We do.

The Laster patent referred to is offered in evidence and marked "Complainant's Exhibit Laster Patent."

Q. 25. State, if you can, whether in bidding for repair work, your company makes any different price for repairs made by the

Perkins process from that asked for repairs made by cutting out the entire surface material?

A. In our bids for this year, as well as that of a year ago, we made a difference of 50 cents a square yard in favor of the Perkins patent.

Q. 26. State what is to be understood by the term "cushion coat" in laying asphalt pavements?

A. It is understood by the term "cushion coat" that it is a coat laid on the hydraulic concrete to level it up to the true grade before the top coat was applied. It was raked down and rolled smooth just in the same manner as the top coat.

After the cushion coat was rolled smooth, the top coat was raked on and rolled upon it, the idea being not only to level up the foundation, but to obtain two compressions as it was considered that two and a half inches of mixture could not be compressed by one rolling.

Q. 27. State whether or not cushion coats are used to any extent at the present time?

A. They are very rarely if ever used now. They proved objectionable because of the frequent failure of the top material to make a bond with the material below. For years this was one of the most frequent causes of failure in asphalt pavements. As a matter of fact the upper and lower layers never were mixed together and very frequently the upper layer would slide on the lower.

Q. 28. Was the cushion layer ever coated with cement for the purpose of securing adhesion between the two layers?

446 A. I have never seen it done.

Q. 29. State whether in laying asphalt mixture pavements the rollers are ever purposely heated?

A. They are not.

Q. 30. State the purpose of putting hydraulic cement on the upper surface of an asphalt pavement?

A. The principal reason is to prevent the roller from sticking to it and taking up the mixture. It also gives a better color and finish. It is used either in making repairs or in laying new pavements.

Q. 31. Is the use of surface hydraulic cement absolutely necessary in laying asphalt pavements or in making repairs?

A. It is not; other means could be used, for instance, in rolling cushions it was customary to spray the wheels with water to prevent the picking up of the mixture by the rollers.

Q. 32. Has your company ever laid any rock asphalt pavements?

A. They have.

Q. 33. State the manner in which repairs have been made in that kind of pavement?

A. The defective portion was cut out with an axe or cutter down to the hydraulic concrete and plugged with new powder, tamped and rolled.

Q. 34. Did or did not this secure an absolute union or bond between the old and new parts?

A. The plug would remain. I never cut one to examine the joint.

Q. 35. State whether to your knowledge the Perkins process of repair was ever used in connection with rock asphalt pavements?

A. I have seen it attempted, but it was a failure.

Q. 36. State why it was a failure?

A. The heat when applied to the surface of the rock pavement seems to dry up and powder the surface or heated portion. When this surface is removed the part below is hard and it is impossible to make a bond between it and new material which may be added.

447 Q. 37. In the attempts to which you refer, was any effort made to open up the old material after removing the heated surface portion?

A. Attempts of this kind were made by using a rake, but the only effect was to scratch the hard surface.

Q. 38. State whether or not you ever took up or cut out a portion of rock pavement that had been repaired by the Perkins process, and if so, what kind of union was effected between the old and new material?

A. I have cut out such a piece, found absolutely no bond or union between the new and the old material. The hole was merely plugged up.

Q. 39. In the effort to repair rock pavement above referred to, was or was not the new material applied as soon as the opening had been made in the pavement, or while it was heated?

A. It was applied at once, as soon as the heated surface was removed.

Q. 40. What is the effect of an apparatus like the Perkins heater upon a rock pavement? Is or is not the latter softened or melted thereby?

A. It is not softened, but powdered or crumbled.

Q. 41. State whether it is possible to melt rock asphalt or to soften the same by heat?

A. It is not. It will remain in its powdered condition even when subjected to a very high temperature. I have myself tried it as high as 325 degrees Fahrenheit.

Q. 42. What would be the effect if you used a Perkins heater and applied the heat until the pavement was disintegrated to a depth of say three-quarters of an inch or an inch?

A. It would absolutely destroy the three-quarters of an inch or an inch, and so harden and evaporate the bitumen in the remaining portion as to render it useless as a paving material.

Q. 43. If the process of operation upon a pavement of asphalt mixture specified in the preceding question had been proposed
448 to you at the date of the Perkins patent, say in 1893, would you or would you not have considered it a practicable method?

A. I would not. I would not try such a method even now.

J. H. CRANFORD, a witness produced on behalf of the complainant, having been first duly sworn, deposes and says:

Q. 1. What is your name, age, residence and occupation?

A. Joseph H. Cranford; age, 28 years; I am vice-president and treasurer of the Cranford Paving Company, and reside in Washington, D. C.

Q. 2. State whether you are familiar with what is known as the "Perkins" method of repairing asphalt pavements?

A. Yes, I am.

Q. 3. State whether you are familiar with the methods previously used in repairing asphalt pavements, and what they consisted of?

A. I am. The old method by which we used to repair pavements was to cut them by means of sharp picks and axes made for that purpose, until we came to the solid hydraulic base, and then repair by placing therein new material.

Q. 4. State whether or not by the Perkins method of repair there was any saving to the municipalities or other persons who had the repairs made over the method of repair previously used?

A. Yes, there was a very large saving. The statistics with which I am familiar show that by the old method of cutting out and plugging the cost was from $1.10 to $1.50 per yard for repairs, while by the Perkins method it is from 60 cents to 90 cents.

Q. 5. Have the changes in the prices of materials in any way affected this difference in prices of the two kinds of repairs?

A. No, they have not.

Q. 6. Is there any saving in the cost of tools by substitut-
449 ing the Perkins method for the prior method of repairs?

A. There is practically no cost for repair of tools by the Perkins method.

HENRY R. KASSON, a witness on behalf of complainant, being first duly sworn, testifies as follows:

Q. 1. What is your name, age, residence and occupation?

A. Henry R. Kasson; age, 39; Kansas City, Mo.; western manager of the Barber Asphalt Paving Co.

Q. 2. State what district is under your supervision?

A. Illinois, Iowa, Nebraska, Kansas, Missouri and Kentucky.

Q. 3. How long have you been continuously connected with the Barber Company?

A. Since 1888.

Q. 4. State whether or not you are familiar with the different methods of repairing asphalt pavements that have been in use since 1888?

A. I am.

Q. 5. Are you familiar with what is known as the Perkins method and apparatus for repairing asphalt pavements?

A. I am.

Q. 6. State the method of repair in general use before the Perkins method was adopted?

A. The method in general use for making repairs to asphalt pavements previous to the introduction of the Perkins method was by cutting out the wearing surface to be repaired through to the concrete or foundation, and then painting the joints with asphalt cement or tar, after which enough new material was tamped in the hole to bring the surface up to the grade of the surrounding pavement, forming a plug, the operation being commonly called "plugging."

450 Q. 7. By the plugging operation described, was or was not the plug united to the part below it?

A. It was not.

Q. 8. In the Perkins method, is or is not the new material united to the part below?

A. It forms an absolute mixture and union with the lower part, without any seam or joint.

Q. 9. State whether you know what opinion was entertained of the Perkins process by those skilled in the art when that process was first proposed?

A. It was the general opinion among asphalt experts that the process known as the Perkins method would prove to be an utter failure, owing to the general opinion that the life of the pavement would be utterly destroyed by the intense heat. That was my own opinion before seeing the process, and I also heard the same opinion expressed by many other expert asphalt men.

Q. 10. If the first step of the Perkins process was stated to you to consist in applying the heat until the pavement, for three-quarters of an inch or an inch, was disintegrated, would or would you not consider that the process was a practicable one?

A. That would be about the same as digging out the material to the concrete and much more expensive. It would not be practicable, commercially speaking.

Q. 11. Examine Letters Patent to Perkins 501,537, and state whether you have ever seen a heater like that used in carrying out the Perkins process?

A. I have.

Q. 12. State whether that style of heater is at present used by the Barber Company?

A. No; it is not. We only used these until 1894.

Q. 13. Examine Complainant's Exhibit Laster Patent, and state whether or not that illustrates any form of heater used by the Barber Company in carrying out the Perkins process?

A. This is practically the machine we are using now. We use two or three different styles, being slight modifications of the Laster machine.

451 Q. 14. State whether any of the machines in use at the present time have a series of burners beneath a hood?

A. No; that style of heater has been practically done away with or given up. I mean the style with the series of burners.

Q. 15. State whether or not these various different styles of heaters are designated by any one name in speaking of them in a general way?

A. They are universally designated as the Perkins Surface Heaters.

Q. 16. Have you anything to do with the payment of the royalties for the Perkins process and apparatus?

A. I have not personally.

Q. 17. Have you any knowledge of the prices charged for repair work upon asphalt pavements?

A. I have.

Q. 18. State whether there is any difference in the charge between repairs made by the Perkins process, and those made by the older process by cutting down to the hydraulic concrete?

A. There is about 50 cents per square yard saving to the municipality in favor of the Perkins process.

Q. 19. State if you have ever made any experiments in the repair of rock asphalt pavements by the use of the Perkins process, and if so, with what result?

A. I made an experiment in repairing a small amount of rock asphalt pavement in Kansas City, Mo. I found that the application of heat to the surface of the rock asphalt caused it to disintegrate or form a powder, and after the part powdered was raked off, the material remaining underneath seemed to be so hard and smooth that it was impossible to make the new surface material adhere to it.

Q. 20. When you raked off the disintegrated portion, did you scratch the surface beneath?

A. It was so hard it would not scratch to any material extent.

452 Q. 21. State how you applied the new material?

A. The new material was applied in a heated condition and was thoroughly compressed by tamping, but we were unable to make the new material form a bond or weld with the old.

Q. 22. Assuming that you had never heard of the Perkins method before trying the experiment with the rock asphalt pavement and that thereafter it had been suggested to you to attempt to repair an asphalt mixture pavement in the same way in which you had attempted the repair of the rock asphalt pavement, would you or would you not have then considered it practical to repair an asphalt mixture pavement by such process?

A. Under those circumstances, I would not have considered it practicable. I would not even have attempted it.

Q. 23. In carrying out the Perkins process, to what depth is the old material softened below the part which is removed?

A. From one-half to three-quarters of an inch, including the part raked off.

Adjourned to 9:30 a. m., January 28, 1898.

CHARLES H. BURWINKLE, being duly sworn, testifies, in answer to questions by counsel for complainant, as follows:

Q. 1. What is your name, age, residence and occupation?

A. Charles H. Burwinkle; age, 39; residence, Philadelphia; I am general yard foreman for the Vulcanite Paving Company of Philadelphia.

Q. 2. How long have you been connected with the business of laying pavements?

A. Since 1886.

Q. 3. Have you ever had anything to do with the laying or repairing of asphalt pavements of any kind?

453. A. I have been laying asphalt mixture pavements since 1886 and repairing the same. I have also repaired rock asphalt pavements.

Q. 4. State the usual method of repairing rock asphalt pavements?

A. By cutting down to the hydraulic concrete and then plugging the hole with new material.

Q. 5. Are you familiar with what is known as the Perkins method of repairing asphalt mixture pavements in which the surface is heated, scraped up by a rake or hoe and then new material added and rolled down?

A. I am.

Q. 6. Have you ever endeavored to repair a rock asphalt pavement or pavements using the same means of repair and the same steps employed in the Perkins method of repair?

A. I have.

Q. 7. State whether or not in the making of repairs with rock asphalt pavements by the Perkins method you secured the same results as are secured in repairing asphalt mixture pavements by the Perkins method?

A. I did not. In the Perkins method with asphalt mixture pavements, the new material is united to the old in a solid bond. In repairing the rock asphalt pavements the result is that the two do not unite.

Q. 8. What is the effect of the heating of the surface of the rock asphalt pavement by means of a heater like the Perkins heater?

A. You heat the surface until it becomes a crisp and when you rake this off there is a hard solid surface underneath.

Q. 9. When you heat the surface of an asphalt mixture pavement by a heater like the Perkins heater, what is the effect?

A. The part underneath the surface is soft and partly melted, so that it will pick up and stand when you work it with a rake.

454 Q. 10. Do you know what the general opinion was among those skilled in the art as to the operativeness of the Perkins mode of repair before the latter was demonstrated?

A. The opinion was that by applying the heat direct to the

pavement, it would burn the pavement, and it would become worthless.

Q. 11. Did you hear that opinion expressed by different parties?

A. I did.

Q. 12. Is it possible to melt or soften rock asphalt by the application of heat?

A. That simply heats it, it doesn't melt. It remains in the form of a powder.

Q. 13. Assuming that you had no knowledge of the Perkins process as applied to asphalt mixture pavements, but had the knowledge which you acquired from your efforts to repair rock asphalt pavements by first heating and then scraping away the disintegrated material, and then adding and rolling in new material would you or would you not have known that this means of repair could be practically applied to repairing asphalt mixture pavements?

A. I would not have known it. On the face of it, I would not have supposed it to be practicable when applied to the asphalt mixture pavement. It would have discouraged my making such an effort.

EUGENE GEORGE SCHWENDEMAN, a witness called on behalf of complainant, being duly sworn, testifies as follows:

Q. 1. What is your name, age, residence and occupation?

A. Eugene George Schwendeman; age, 34; I am street superintendent for the Vulcanite Paving Company; residence, Philadelphia.

Q. 2. How long have you had anything to do with the laying of pavements and what kind of pavements have you laid?

455 A. I have laid most all kinds of pavements since 1882.

Q. 3. Are you familiar with the modes of laying asphalt mixture pavements and rock asphalt pavements, and of the modes of repairing the same?

A. I am.

Q. 4. Have you ever made use of what is known as the Perkins mode or apparatus for repairing pavements?

A. Yes, sir.

Q. 5. Have you ever used or attempted to use the Perkins mode of repair and the Perkins apparatus for the purpose of repairing rock asphalt pavements?

A. I have.

Q. 6. Have you or have you not found the Perkins method to be successful in connection with rock asphalt pavements?

A. I have not.

Q. 7. Why not?

A. Because the new material only plugs the hole, but does not unite with the old material.

Q. 8. Does a heater like the Perkins heater have the same effect in operating on a rock asphalt pavement that it has in operating on a pavement of asphalt mixture?

A. It does not. On a rock asphalt, it burns and chars the pavement, so that when you scrape the charred part off, the bottom or underneath part is hard and dry, so that it is an impossibility to make a bond with the new material placed on top; where with other asphalts when the upper portion is removed, the pavement underneath is soft and very pliable; in fact, it seems to be the same as when it was originally placed there before it was rolled; then by adding the new stuff on top of it, it makes a perfect bond.

Q. 9. Did you know what was the general opinion as to the practicability of the Perkins method when it was first proposed?

A. I did; it was that it would not be a success.

456 Q. 10. Did you hear many persons express this opinion?

A. I did. Nobody that I know of that was connected with the business at that time would believe in it, until it was demonstrated.

Q. 11. If before knowing of the Perkins process, you had had knowledge that a rock asphalt pavement could be burnt out, forming a hole or depression, which could be plugged up with new material, would or would not this knowledge have shown you that an asphalt mixture pavement could be repaired by means of a heater so as to secure a union of the old and new material; in other words, would or would you not have known from the results with rock asphalt that it would be practicable to use such a method as the Perkins method for repairing asphalt mixture pavements?

A. I do not think I would. I would have had to try experiments to find out whether or not the heat would destroy the pavement down to the concrete.

Q. 12. State whether or not the use of cushion coats proved to be a success?

A. They were not; they were abandoned.

Q. 13. Why were they abandoned?

A. Because the upper and lower layers would not unite.

VOLNEY W. FOSTER, a witness called on behalf of complainant, being duly sworn, testified in answer to questions proposed by Mr. W. R. Omohundro, as follows:

Q. 1. Are you the Mr. V. W. Foster who has before testified on behalf of complainant in this cause?

A. Yes.

Q. 2. I believe you are the president of the United States Repair and Guaranty Company, one of the complainants in this cause?

A. I am.

457 Q. 3. Do you know to what extent the Perkins heaters made in accordance with the Perkins patents, Nos. 501,536 and 517,191, which patents were included in the license that was granted under the method patent to your various licenses, were used and are used?

A. The apparatus of Patent 501,536 was in general use for about a year, that is, during the year 1894; since that time other forms of hoods and burners have been substituted and applied to the same uses. The apparatus of Patent No. 517,191 has not been used. Since the latter part of 1894, the first form of heaters has been generally abandoned and the new forms have been adopted.

Q. 4. Please state whether some of these newer forms have been built and furnished by your company, and also whether some of them have been devised and constructed by your licensees?

A. Some of the forms of heaters now in use, being the later forms referred to, have been constructed by us, and others have been devised and constructed by licensees.

Q. 5. I show you Complainant's Exhibit Laster Patent, and ask you to state whether any of the apparatus therein shown have been constructed and generally used by any of your licensees, and if so, which one?

A. I have observed this form of heater in use by the Barber Asphalt Paving Company, and am informed that they have generally used it.

Q. 6. Please state whether, notwithstanding the use by the licensees of the various forms of heating apparatus there has been any difference made in the amount of royalties paid your company under the licenses granted by it?

A. No difference has been made and royalties are paid regular-

ly by all our licensees regardless of what kind of heating apparatus they may use.

Q. 7. Are you personally familiar with the methods of repairing asphalt pavements by the old plan of chopping out as well
458 by the Perkins method, and also as to the relative cost of repairs by these different methods?

A. I am.

Q. 8. Please state whether you know that a saving to municipalities is effected when repairs are made by the Perkins method as compared with the old method?

A. I do.

Q. 9. Please state whether such saving has been effected or brought about by any change or reduction in the cost of materials used in making the repairs to the surface layer of asphalt above the foundation?

A. It has not.

Q. 10. State whether or not the same proportionate saving in the cost of repairs to the surface layer of asphalt pavements by the Perkins method, as compared with the old method of chopping out, would be effected regardless of any change in the cost of material or labor?

A. The proportion of the saving by the use of the Perkins method would remain the same regardless of the decline in the value of the materials used in repair.

Q. 11. Please state whether you are connected with any concern actually engaged in the laying and repair of asphalt pavements, and if so, please state what concern and in what capacity you are connected with it?

A. I am president of the Western Paving and Supply Company, of Chicago, asphalt pavers, which company is a licensee under the patent in suit and uses the Perkins method in the repair of asphalt mixture pavements.

Q. 12. State whether you have any knowledge of the introduction of the Perkins method in the repair of asphalt mixture pavements, and also state briefly what efforts were made for the general introduction thereof and how you were met by those skilled in the art when the Perkins method was first proposed?

459 A. Mr. Perkins, whose name appears in the patents, was an employee and officer of the Western Paving and Supply Company, and while in that position, being continually and persistently urged by me to invent some more economical and scientific method of repair than the one then in use, namely, chopping out the hole of the defective portion of the surface layer of the

pavement, he did undertake a series of experiments which ended in the device and process which was patented and is known as the Perkins Surface Heater and Method of Repair. When this method of repair was first brought to the notice of others skilled in this art, they uniformly pronounced it impracticable and useless, giving as a reason that it would burn and destroy, for practical use, the asphaltic ingredients of the composition of the entire upper layer of the part heated. We could not get permission from any contractor having a pavement under guarantee to consent to our demonstrating our method and its practicability. This was first done upon pavements laid by the Western Paving and Supply Company. Even after we had made repairs with this method, asphalt pavers with whom we sought to make contracts for the use of the Perkins method were not satisfied with the evidence of the repair in place, but had sections of such repair places cut out and removed for examination and experiment to prove that there was a bond and that the method had made a perfect weld of the old and new materials. The value of the Perkins method was not admitted until after we had demonstrated over and over again that the action of the heat and the oxygen of the air formed first a crust upon the pavement of about the thickness of a sheet of blotting paper, and that the effect of the heat upon the portion of the pavement below the crust was to melt it, but not to burn it, in effect restoring it to its original condition before it was compressed. After these facts were proved, we had no difficulty in making royalty leases with the prominent asphalt pavers of the United States.

VOLNEY W. FOSTER.

460

461 It is further stipulated and agreed that the several licenses issued by the Complainant under the Perkins method and apparatus patents, as mentioned in the depositions of Volney W. Foster, had distinct provisions restricting the licensee in each instance to the use of the Perkins inventions aforesaid for the repair of asphalt mixture pavements theretofore laid by such licensee only. A copy of Perkins patent No. 517,191, March 27, 1894, Method of and Apparatus for Repairing Asphalt Pavements, included in the licenses, is here offered in evidence and marked Complainant's Exhibit "Perkins Air-Blast Patent."

It is further stipulated that the repairs of rock asphalt pavement attempted by the Perkins method, as testified unto by the

witnesses Burwinkle and Schwendeman were conducted by the use of a Perkins heater substantially such as shown in patent No. 560,599, May 19, 1896, here in suit, and designated as Complainant's Exhibit "Perkins Apparatus Patent No. 2." Such attempted repairs were conducted by said witnesses under supervision of the witness William H. Lober and are the same as Lober himself testifies about.

RAYMOND & OMOHUNDRO,
Solicitors for Complainant.
PEIRCE & FISHER,
Solicitors for Defendants.

Washington, D. C., March 1, 1898.
Adjourned subject to notice.

462 United States of America, } ss.
District of Columbia. }

I, W. Clarence Duvall, a Notary Public in and for the District of Columbia, do hereby certify over my hand and official seal, that upon the 23d, 24th, 25th, 26th and 28th days of February, 1898, in the case of the United States Repair & Guaranty Company v. Assyrian Asphalt Company et al., now pending in the U. S. Circuit Court for the Northern District of Illinois, at the office of Foster & Freeman, in the City of Washington, I duly swore and took the deposition of Charles Elwood Foster, of Washington, D. C., that Mr. W. R. Omohundro conducted the examination for the Complainant, Mr. James H. Peirce conducted the examination for the Defendants, and made objections and stipulations as above written; that said deposition was taken directly upon a typewriter by consent of counsel, and was duly examined and signed by said witness.

Witness my hand and official seal this first day of March, A. D. 1898.

(Seal.)

W. CLARENCE DUVALL,
Notary Public in and for said District.

463 IN THE CIRCUIT COURT OF THE UNITED STATES.

Northern District of Illinois.

U. S. Repair & Guaranty Company vs. Assyrian Asphalt Company et al., } In Chancery. No. 24,534.

COMPLAINANT'S REBUTTAL CONTINUED.

Testimony taken and evidence adduced in behalf of complainant pursuant to agreement of counsel, formal notice being waived, and the stipulation subsisting between the parties, before C. L. Wood, a notary public in and for the County of Cook, in the State of Illinois, at the offices of Messrs. Raymond & Omohundro, room 1515 Monadnock Block, Chicago, Illinois, commencing at 11 o'clock a. m. on Thursday, October 27, 1898.

Present: Mr. W. R. Omohundro, of Raymond & Omohundro, solicitors for complainant; and Mr. J. H. Peirce of Peirce & Fisher, solicitors for defendant.

And thereupon the following stipulation was entered into between the solicitors for the respective parties to the above-entitled cause:

464 STIPULATION.

To avoid the expense and delay of taking the testimony of Messrs. A. L. Barber, Stevenson Towle, Clifford Richardson and Edward P. North, it is hereby stipulated and agreed between the attorneys for the respective parties that the following affidavits of said named persons shall be duly admitted and taken as part of the testimony on complainant's behalf, the same as if the facts therein stated were adduced by regular depositions, defendants' counsel not admitting the matters thus testified about are true, nor that all of the facts and circumstances relevant to the laying of Barber asphalt composition pavements in Europe and tending to explain the failure thereof have been fully set forth. Defendants' solicitor reserves the right to take further testimony on this head should defendants so elect.

Complainant's solicitor does not concede the right of defendants to take further testimony at this stage, and declines to consent

thereto unless the court shall so direct on motion duly made to such effect.

RAYMOND & OMOHUNDRO,
Solicitors for Complaiant.
PEIRCE & FISHER,
Solicitors for Defendant.

Following are copies of the affidavits referred to in the foregoing stipulation:

465 IN THE UNITED STATES CIRCUIT COURT.

Northern District of Illinois.

U. S. Repair & Guaranty Company vs. Assyrian Asphalt Company et al., } In Chancery. No. 24,534.

AFFIDAVIT.

State of Colorado, County of Arapahoe. } ss.

A. L. Barber, of New York City, being first duly sworn, deposes and says as follows, to wit:

First. That he, the said A. L. Barber, is chairman of the Barber Asphalt Paving Company, a corporation of West Virginia; that he has been thoroughly familiar with the asphalt paving business in the United States since the year 1878, when he first went into the business of laying Trinidad asphalt mixture pavements in Washington, D. C.; that the operations of the Barber Asphalt Paving Company in the laying of Trinidad asphalt mixture pavements has extended over the entire United States; and that the said company now maintains branch offices or agencies at Washington, D. C., New York City, N. Y., Buffalo, N. Y., Kansas City, Mo., and most of the other principal cities of the United States.

Second. That he, the said Barber, has been thoroughly familiar with the business of laying asphalt pavements in Europe since the year 1879; that he has personally visited London, Paris, Berlin and many other of the principal cities in Europe many times during the last twenty years; and that he has been thoroughly
466 familiar with the processes, methods and materials used in the laying of asphalt pavements in Europe since 1879.

Third. That to his, the said Barber's, personal knowledge, information and belief, with the exceptions hereinafter stated, the invariable material used in Europe in the laying of asphalt pavements, since 1879, for roadways or streets was natural rock asphalt in a dry powdered form, while the sidewalk materials was a mixture of natural rock asphalt enriched with Trinidad bitumen, and commonly called asphalt "coule" or "mastic;" that the sidewalk pavements are laid in a manner entirely different from the roadways, the latter being laid with a dry, powdered natural rock asphalt in a heated state, called in the finished state, in French, "asphalt comprime," while all the sidewalks throughout Europe, on the other hand, are laid "coule," or, as we would say in English, with "mastic;" that he understands the word "coule" might be translated by the word "flowed," and "comprime" by the word "compressed;" and that the asphalt coule is laid in much the same manner that ordinary plaster is applied to a wall.

Fourth. That the material invariably used in the laying of sidewalks throughout Europe is composed of ordinary rock asphalt which has been melted and enriched, usually with Trinidad bitumen, and made into cakes of various shapes, which cakes, when a sidewalk is to be laid, are broken up into small pieces and put into a kettle, into which a small quantity of pure bitumen or Trinidad asphalt has been previously placed and melted; that 467 these cakes are thoroughly melted, a certain proportion of broken stone is added, and the whole is made into a thick, plastic mass, which is shovelled into pails, carried to the place for laying and emptied thereon, and spread out by means of a wooden float or trowel to a thickness usually of about one inch.

Fifth. That he, the said Barber, knows of his own knowledge that the pavements commonly laid and known in the United States as asphalt pavements are composed of a mixture of sand, asphalt and petroleum residuum in about the proportions of 75 per cent. of sand, 15 per cent. of asphaltum, containing a small quantity of residuum, and about 10 per cent. of limestone flour, which said materials, when mixed and heated to a temperature of about 350 degrees, form a thick, heavy mass that is spread upon a suitable foundation with shovels, rakes and hoes, levelled, rolled and compressed to form the roadway or street pavement.

Sixth. That he, the said Barber, personally knows that no asphalt mixture pavements such as is above described, have ever been laid or used in Europe, with the exception of work done by the Barber Asphalt Paving Company on the Rue de Rivoli, near the City Hall, in Paris, in the fall of 1886 and the early part of

1887, and another piece of pavement laid by the Barber Asphalt Paving Company in the fall of 1886 and the spring of 1887 on the Landsberger strasse, in the City of Berlin, Germany; that both of these pavements were composed of the materials commonly used in the laying of asphalt mixture pavements in the United States at that date, and were composed of about 85 per cent. sand, 15 per cent. Trinidad asphalt paving cement, which cement in turn was composed of about 80 per cent. of refined Trinidad as-
468 phalt and the balance of petroleum residuum, the sand containing in these instances a sufficient percentage of limestone powder to render it unnecessary to add that element to the compound; that both of said pavements so laid in Paris and Berlin proved utter failures by reason of the climatic conditions and heavy traffic to which they were subjected, and that both of the pavements so laid in Paris and Berlin were entirely removed at the expense of the Barber Asphalt Paving Company very shortly after they were laid.

Seventh. That again, in the year 1894, to deponent's certain knowledge, an attempt was made to lay an asphalt mixture pavement in London, England, in exact accordance with the best methods practiced in the United States at that time, and with the best materials and mixture of materials for laying such pavements used in the United States at that time; that such pavements also proved absolute failures from the start on account of climatic conditions and the heavy traffic to which they were subjected, and had to be subsequently removed; and that it was not until the year 1896 that an asphalt mixture pavement compound was invented and successfully laid in London, England, that would withstand the climatic conditions and traffic to which it was subjected and that would prove successful in any European country.

Eighth. That he, the said Barber, was personally present during the mixing of the asphalt pavement compound and during the laying of the same in Paris and in Berlin, as referred to in the sixth paragraph of this affidavit, and that he personally knows that
469 the ingredients and the proportions of ingredients of said pavement mentioned in said paragraph six are true and correct, and that the said materials were mixed and heated to a temperature of about three hundred and fifty (350) degrees Fahrenheit, and while in such heated condition were spread upon a concrete foundation with shovels, rakes and hoes, levelled, rolled and compressed to form the roadway or street pavement in the usual manner and with the best machinery, tools, materials and labor

commonly employed in the United States at that date in the laying of such asphalt mixture pavements.

Ninth. That the foregoing affidavit is made for the purpose of being used as testimony in the suit of the U. S. Repair and Guaranty Company vs. Assyrian Asphalt Company et al., now pending in the Circuit Court of the United States for the Northern District of Illinois.

And further affiant saith not.

A. L. BARBER.

Subscribed and sworn to before me, this 22nd day of October, A. D. 1898.

F. P. COUGHLIN,

(Seal.) Notary Public in and for the County of Arapahoe, State of Colorado.

470 IN THE UNITED STATES CIRCUIT COURT.

Northern District of Illinois.

U. S. Repair & Guaranty Company vs. Assyrian Asphalt Company et al., } No. 24,534. In Chancery.

AFFIDAVIT.

State of New York, County of New York. } ss.

Stevenson Towle, of New York City, being first duly sworn, deposes and says as follows, to wit:

First. That the said Stevenson Towle was recently chief engineer of highways of the City of New York; he has been engaged in the practice of engineering, especially in connection with public highways, for the past forty years, and that he is thoroughly familiar with the methods and materials used in the laying of asphalt pavements in the United States, and has been since their first general introduction or use, some twenty-five years ago.

Second. That he is personally familiar with the processes, methods and materials used in the laying of asphalt pavement in Europe, and has been so familiar for the past twenty years, and

has personally visited Paris, London, Berlin and most of the principal cities at intervals during the past thirty years.

Third. That he knows, of his own knowledge, that the asphalt pavements laid in the roadways or streets of the cities of Europe have been composed of natur... rock asphalt, reduced to a powder, heated and laid under compression; and the sidewalks of the
471 principal cities of Europe have been invariably laid with (asphalt) "Coule" or "mastic," consisting of ground rock asphalt mixed generally with Trinidad bitumen and heated so as to make a thick plastic mass, which is spread upon the sidewalk foundation with a float to the depth of about one-half inch.

Fourth. That the asphalt pavements commonly known and used in the United States since the year 1874 have invariably been composed of a mixture of sand, Trinidad, or similar, asphalt, petroleum residuum and lime stone flour, in about the proportion of seventy-five (75) per cent. of sand, twelve and one-half (12 1-2) per cent. of refined asphalt, which is mixed with a small proportion of petroleum, and about ten (10) per cent. of limestone flour.

Fifth. That to his personal knowledge, asphalt mixture pavements of the character above described have never been known or used in Europe since the year 1876, except pieces of pavement laid in Paris and Berlin in 1886 and 1887, by the Barber Asphalt Paving Company, which pavements proved unsuccessful and failures because of the climatic conditions and heavy traffic to which they were subjected, and which pavements were removed soon after they were laid.

Sixth. That he knows that no asphalt mixture pavements, of the kind above described, were successfully laid or used, or could be successfully laid or used, in Europe with the known methods and materials prior to the year 1896, on account of the peculiar climatic conditions and heavy traffic to which all streets or roadway pavements in Europe are subjected.

472 Seventh. That he, the said Towle, was not personally present during the mixing of the materials composing the asphalt pavement compound, nor during the laying of the same in Paris and Berlin in the years 1886 and 1887, as referred to in the fifth paragraph of this affidavit, but that he visited the said cities a short time after the said pavements were laid and inspected the same, and also visited the said cities at, or about, the time the said pavements were removed, and personally knows that the reason for remval of said pavements, stated in the said fifth paragraph of this affidavit, are true and correct to the best of his knowledge, information and belief.

Eighth. Affiant further states that he is not interested, either directly or indirectly, in the said cause or in the outcome thereof.

Ninth. That the foregoing affidavit is made for the purpose of being used as testimony in the suit of the U. S. Repair and Guaranty Company v. Assyrian Asphalt Paving Company et al., now pending in the Circuit Court of the United States for the Northern District of Illinois.

And further affiant saith not.

STEVENSON TOWLE.

Subscribed and sworn to before me this 20th day of October, A. D. 1898.

VICTOR E. SCHAUMBURG,
(Seal.) Notary Public in and for the County and State aforesaid.

473 IN THE CIRCUIT COURT OF THE UNITED STATES.

For the Northern District of Illinois.

U. S. Repair & Guaranty Company vs. Assyrian Asphalt Company et al. } In Chancery. No. 24,534.

AFFIDAVIT.

State of New York, County of Queens. } ss.

Clifford Richardson, of New York City, being first duly sworn, deposes and says as follows, to wit:

First. That he, the said Clifford Richardson, is an analytical chemist by profession, and has been following said profession for the past twenty years; that he is now employed as superintendent of tests by the Barber Asphalt Paving Company at its laboratory at Long Island City, New York; that he has been thoroughly familiar with the asphalt paving business in the United States for the past eleven years, and that he formerly occupied the position of inspector of asphalt and cements at Washington, D. C., during the years 1887 to 1894.

Second. That he, the said Richardson, is familiar with the material used in the laying of asphalt pavements in Europe, but that

his personal information from actual inspection of pavements laid in London, Paris, Berlin and other principal cities of Europe commenced in the year 1894; that the material used in Europe for street pavements or roadways is, and has been, natural rock asphalt, laid in the manner called, in French, "asphalt comprime,"
while the sidewalk material is a mixture of natural rock as-
474 phalt enriched with Trinidad bitumen and commonly called
"asphalt coule" or "mastic"; that the natural rock asphalt used for street pavements and roadways is laid in a heated dry powdered form rolled and compressed into a sheet, while the mastic is laid, as its name would indicate, in much the same manner as ordinary plaster is applied to walls or as a cement sidewalk is laid.

Third. That the mastic is composed of ordinary rock asphalt which has been melted and enriched with Trinidad bitumen to which is added a certain proportion of gravel or broken stone, and that such material differs widely from the asphalt pavements commonly known and laid in the United States; that the asphalt pavements commonly known and laid in the United States are composed of a mixture of sand, asphalt and petroleum residuum in about the proportion of 75 per cent. of sand, 15 per cent. of asphaltum, containing a small quantity of residuum, and about 10 per cent. of limestone flour, which said materials are mixed together and subjected to a temperature of about 350 degrees Fahrenheit, forming a thick, heavy mass that is not fluid like the mastic, but is more granular in character, being held together by the sticky asphalt so that the mass may be spread upon a suitable foundation, leveled with a rake, hoe or similar implement, rolled and compressed to form the roadway or street pavement.

Fourth. That he, the said Richardson, knows of his own knowledge that in the year 1894 there were no pavements of the
asphaltic mixture or compound, such as is commonly used in
475 the United States, in existence anywhere in Europe until he,
the said Richardson, in the year 1894, attempted to lay an asphalt mixture pavement in London, England, in exact accordance with the best methods practiced in the United States at that time, and with the best materials and mixture of materials for the laying of such pavements used in the United States at that time; that such pavements so laid by him, the said Richardson, proved absolute failures from the start, on account of the climatic conditions and the heavy traffic to which they were subjected, and had to be removed soon after being laid. Again in 1895, he, the

said Richardson, laid another pavement of the asphalt mixture type, which again proved a failure and had to be removed.

Fifth. That he, the said Richardson, after continued study and experiment, finally succeeded in laying an asphalt mixture pavement in London, England, of the same general character as the asphalt mixture pavement of the United States, that would withstand the climatic conditions and traffic to which it was subjected, and which would prove successful in any European countries, but that he, the said Richardson, had to invent a new compound or asphalt mixture to meet the conditions of climate and traffic, for which said mixture letters of patent of Great Britain, No. 9,315, were granted the said Richardson May 29, 1897.

Sixth. That he, the said Richardson, having been in London, Paris and Berlin in 1894, and having examined the pavements in these cities and had long conversations with the officials who were responsible for the construction of the pavements of such 476 cities, found, at that time, that there were no street surfaces of asphalt of the asphalt mixture type such as those in use since 1875 in the United States, and that until 1896 asphalt pavements, other than those made from rock asphalt, were practically unknown, and, in fact, unused, in London, Paris and Berlin, and all of the principal cities of Europe, being regarded as an entire failure.

Seventh. That he, the said Richardson, has examined a copy of the French Letters Patent granted Paul Crochet in 1881, and states that in his opinion there is no doubt whatever that the term "les chaussees en bitume" refers solely to the word known as "mastic" and could in no sense be held to describe the form of asphalt mixture pavement commonly in use in the United States, and that the invention patented by Crochet was intended to apply solely to asphalt surfaces composed of rock asphalt or of mastic.

Eighth. That he, the said Richardson, states without hesitancy or qualification that a familiarity with the characteristics of asphalt mixture pavements, such as were laid in the United States at the time of the granting of the Perkins patents, to wit, 1893 and 1894, and also a knowledge of the Crochet patent, would not, in his opinion, have led those who were endeavoring to devise an economical method of repairing these asphalt mixture surfaces to undertake this by means of the process devised by Crochet or Perkins, and that in fact when the Perkins method and apparatus for repairing asphalt mixture pavements was submitted to the said Richardson for approval he did not believe it could be successfully applied to the purpose for which it was designed, but, on the

477 contrary, his knowledge of the nature of the asphalt surfaces at that time in use in the United Statecs led him to believe that the entire surface would be destroyed rather than that the upper portion could be burned and removed without injuring the lower part of the asphalt mixture.

Ninth. That he, the said Richardson, was personally present during the mixing of the materials used in laying the asphalt mixture pavement in London, England, in the year 1894, referred to in clause 4 of this affidavit; that said pavement was laid under his personal superintendence and direction, and that the asphalt mixture forming said pavement was composed of a mixture of sand, asphaltum and petroleum residuum in the proportions of seventy-five (75) per cent. of sand, fifteen (15) per cent. of asphaltum, containing a small quantity of residuum, and ten (10) per cent. of limestone flour, which said materials were mixed together and subjected to a temperature of about three hundred and fifty (350) degrees Fahrenheit, and while in this heated condition was laid upon a concrete foundation, rolled, tamped and burnished in the usual manner with such pavements; that in the laying of such pavements, which covered an area of 5,000 square yards, there were employed about forty men, about twenty-five of whom were employed in mixing the material and transporting the same to be laid, and the balance were employed in the actual laying and finishing of the pavement; that of the number of men so employed six (6) were citizens or residents of the United States, who were taken to London for the express purpose of actually laying the said pavement, and who were so employed for their special
478 skill in this particular work; that three men of said number employed in the mixing of the materials were citizens or residents of the United States who were taken over to London for the express purpose of taking part in the actual mixing of the materials.

Tenth. That the foregoing affidavit is made for the purpose of being used as testimony in the suit of the U. S. Repair and Guaranty Company vs. Assyrian Asphalt Paving Company et al., now pending in the Circuit Court of the United States for the Northern District of Illinois.

And further affiant saith not.

CLIFFORD RICHARDSON.

Subscribed and sworn to before me, this 20th day of October, A. D. 1898.

J. R. LAW, JR.,

(Seal.) Notary Public in and for the County, in the State aforesaid.

IN THE UNITED STATES CIRCUIT COURT.

Northern District of Illinois.

U. S. Repair & Guaranty Company vs. Assyrian Asphalt Company et al. } In Chancery. No. 24,534.

AFFIDAVIT.

State of New York, County of New York. } ss.

Edward P. North, of New York City, being first duly sworn, deposes and says as follows, to wit:

First. That he, the said North, had charge of the streets 479 and roads in what is now the Borough of the Bronx from the summer of 1866 to the spring of 1868, and was water purveyor and consulting engineer for the department of public works of the City of New York for three years, from March 25, 1895, to February 28, 1898, having charge of paving and repairing of all the streets of the city; that he has been engaged in the practice of engineering for forty-seven years, especially in connection with public highways for the past twenty-two years, and that he is familiar with the methods and materials used in the laying of asphalt pavements in the United States, and has been since their first introduction or use in 1870.

Second. That he is personally familiar with the processes, methods and materials used in the laying of asphalt pavements in Europe, and has been so familiar for the past twenty years, and has personally visited Paris, London and most of the principal cities of Europe a number of times since the year 1873.

Third. That he has never heard of any other than rock asphalt, known as asphalte comprime, being successfully laid in any European city for a wheelway pavement; that he has kept informed as to the asphalt paving industry in Europe for the past twenty years, and that to the best of his knowledge and belief asphalt pavements successfully laid in the roadways or streets of Paris, London, Berlin and other European cities have been invariably composed of natural rock asphalt, reduced to a powder, heated and laid under compression; and that the sidewalks of the principal cities of Europe have been invariably laid with asphalt "coule" or "mastic,"

consisting of ground rock asphalt mixed generally with Trinidad bitumen and gravel, and heated so as to make a thick, plastic
480 mass, which is spread upon the sidewalk foundation with a float to a depth of about one-half inch, excepting that in London asphalt comprime has been laid on sidewalks; that he is personally acquainted with many of the directors and several managers of the mines producing the largest amount of rock asphalt in Europe, and that while he personally has not examined every asphalt pavement in Europe, yet he is quite certain that he would have known whether any other pavements, except rock asphalt, had been successfully laid.

Fourth. That in the cities of Paris and London, pavements were laid in the years 1886 and 1887 by or for the Barber Asphalt Paving Company, which said pavements, to the best of affiant's information and belief, were composed of a mixture of sand, Trinidad asphalt, petroleum residuum and limestone flour in about the proportions of seventy-five (75) per cent. of sand, fifteen (15) per cent. of refined asphalt, containing a small proportion of petroleum residuum, and about ten (10) per cent. of limestone flour; that by expert report he knows the said pavements proved unsuccessful and a failure, and were taken up after being in use a short time.

Fifth. That he, the said North, was not present during the mixing of the materials and the laying of the asphalt mixture pavements, referred to in the foregoing paragraph, but that his profession necessitated his keeping thoroughly informed as to the materials and methods of laying asphalt pavements of all kinds, both in the United States and in Europe, and that he personally visited the cities of Paris and London shortly after the said
481 pavements were laid and removed, and that, from his investigations made at that time, he is informed and believes that the foregoing statements with regard to said pavements are true, and that the reason for the failure of said pavements was caused by the climatic conditions and heavy traffic to which said pavements were subjected.

Sixth. That, to the said North's personal knowledge, asphalt mixture pavements of the character described in paragraph fourth of this affidavit are such as have been commonly known and used in the United States since the year 1870, and have, when not adulterated with gas tar, invariably been composed of a mixture of sand, Trinidad or similar asphalt, petroleum residuum and lime or other stone flour, in about the proportions of seventy-five (75) per cent. sand, twelve to fifteen (12 to 15) per cent. of refined asphalt,

with which is mixed a small proportion of petroleum residuum or maltha, and about ten to thirteen (10 to 13) per cent. of limestone flour; and that no asphalt mixture pavements, of the kind described, were successfully laid or used in Europe with the known methods and materials prior to the year 1896, on account of the peculiar climatic conditions and heavy traffic to which all streets or roadway pavements in Europe are subjected.

Seventh. Affiant further states that he is not interested, either directly or indirectly, in the said cause or in the outcome thereof.

Eighth. That the foregoing affidavit is made for the purpose of being used as testimony in the suit of the U. S. Repair & Guaranty Company v. Assyrian Asphalt Paving Company et al., now
482 pending in the Circuit Court of the United States for the Northern District of Illinois.

And further affiant saith not.

EDWARD P. NORTH.

Subscribed and sworn to before me this 31st day of October, A. D. 1898.

J. P. WHITEHORN,

(Seal.) Notary Public in and for the County in the State aforesaid.

Solicitors for complainant here offer in evidence the original affidavits referred to in the foregoing stipulation, and the same are marked respectively "Complainant's Exhibit Barber Affidavit," "Complainant's Exhibit Towle Affidavit," "Complainant's Exhibit Richardson Affidavit." "Complainant's Exhibit North Affidavit."

And thereupon, by agreement of counsel, the further taking of testimony was adjourned to Saturday, October 29, 1898, at 10:30 o'clock a. m.

Chicago, October 29, 1898.

Met pursuant to adjournment.

Parties present as before.

MELVILLE E. DAYTON, a witness produced on behalf of complainant, testified in answer to interrogatories propounded to him by W. R. Omohundro, Esq., as follows:

Q. 1. Are you the same Melville E. Dayton who formerly testified in this cause?

A. I am.

483 Q. 2. Have you examined, and do you understand, the prior United States and foreign patents offered in evidence by the defendant since the giving of your former disposition, and especially the French patent to Paul Crochet of 1881?

A. I have, and believe I do.

Q. 3. Have you read the various printed publications offered in evidence by defendants since the giving of your former deposition?

A. I have, but as I am not a French scholar I have relied upon the translations offered in evidence by defendants of the several articles printed in the French language, as well as of the Crochet patent.

Q. 4. Have you read the affidavits and the testimony taken by complainant since you gave your former disposition?

A. I have looked over the testimony taken by complainant since I gave my former deposition in a general way, but cannot say that I now recall the same with certainty as to the details thereof. The affidavits referred to I have carefully and recently read in connection with the printed matter offered in evidence by defendants.

Q. 5. Please state what bearing, if any, the patents and publications offered in evidence by defendants have, in your opinion, upon the Perkins method patent, No. 501,537, in suit, tending to restrict the invention set forth in claim 1 of said patent. You may consider the whole matter of these patents and publications fully, giving your reasons for any opinions you may express.

484 A. The defendants' exhibit patents and publications are the following:

A. Crochet patent.
B. Malo Article No. 1.
C. Malo Article No. 2.
D. Beckwith Article.
E. Engineering Article.
F. Chabrier Article.
G. Malo Article No. 3.
H. Correspondence on Asphalt.
I. Malo Book.
N. Craig Patent.
O. Bogia Patent.
P. Waterbury Patent No. 1.
Q. Waterbury Patent No. 2.
R. Hayes Patent.
S. Kendrick Patent.

T. Zimmerling Patent.
U. Curl Patent.
V. Risdon Patent.
Perkins Senior Apparatus Patent.

These patents are all offered "to show the state of the art prior "to the dates of the respective Perkins inventions here in con- "troversy." Only Exhibits A to I, inclusive, relate to the Perkins Method patent, No. 501,537, in suit, or are intended to be understood to relate to that patent, I am informed, so that only said exhibits A to I, inclusive, need be considered in this answer.

No testimony concerning these exhibits, or pointing out their bearing upon the Perkins Method patent, has been offered in behalf of defendants.

485 The Perkins patent, No. 501,537, is a United States patent, and relates to a method of repairing asphalt pavements of the kind known only in the United States at the date of said patent, and which, therefore, may properly be distinguished as "American Asphalt Pavements." The defendants' exhibits A to I, inclusive, pertain to asphalt pavements of the kinds more commonly found in France, where they are designated usually by specific names applied to the two principal varieties thereof. Although these foreign asphalt pavements are not confined to France, they may conveniently and properly be designated as "French Asphalt Pavements."

The difference between the pavement which I have called "American asphalt pavement" and the pavements which I have similarly called "French asphalt pavements" are so marked that there is a dispute of our right to call our pavement "asphalt" pavement at all. This appears, I believe, in some of defendants' exhibit publications in this case.

Our American asphalt pavement, it will be remembered from the description given in my *prima facie* deposition and by other of complainant's *prima facie* witnesses, consists of an artificial mixture of which the principal ingredient is sand. This sand forms seventy-five (75%) per cent. of the mixture, and this, with a ten (10%) per cent. solid ingredient in the form of powdered limestone, is cemented to form the pavement covering by a fifteen (15%) per cent. ingredient or "cement," composed of refined lake asphalt adapted to be made more fluid when heated by the addition thereto of a small quantity of heavy petroleum or residuum oil. This cement is technically known as "asphalt cement."

486 The "French asphalt pavements" are, as stated, of two

principal varieties, namely, "compressed asphalt" and "mastic," sometimes called bitumen pavements. These distinctions are clearly made in the defendants' exhibit publications, which publications further show that "compressed asphalt" pavements are for "roadways" subject to team traffic, and that the "mastic" or "bitumen" pavements are for "footways" or "sidewalks," as well as for vault flooring and other surfaces subject to the tread of foot passengers, beside being used for walls and ceilings, possibly.

In "compressed asphalt" pavements the top layer of the pavement (say an inch and a half to two inches and a half in thickness) consists exclusively of a single natural material known as "rock asphalt." This is found in massive solid strata and is quarried or mined like other rock. It is usually a limestone and it is impregnated throughout with bitumen. When subjected to considerable heat it "decrepitates" or breaks up into a granular powder. According to the defendants' exhibit publications, the masses taken from the mines or quarries are crushed to large fragments, and these fragments further reduced to powder, generally by "decrepitation" under heat, or sometimes the harder varieties are powdered by further grinding. Under heavy pressure, this powder or rock asphalt may be solidified, even if the material be cold, but such solidification is facilitated by heating the powder before subjecting it to compression on the roadway. As Defendants' Exhibit (B) Malo Article No. 1 puts it (page 13 of the translation):

" Rock asphalt heated, pulverized by decrepitation, laid
487 down over the body of the street, tamped and compressed by rollers, resumes on cooling the state in which it is found in its deposits; this it is which produces its strength, its elasticity, its homogeniety, its *solidarity*."

A "compressed asphalt pavement" is therefore substantially a ***natural rock*** distributed to a uniform thickness over the surface of a roadway. Its transportation from the mines to the street and its transformation into the uniform sheet in which it exists on the pavement have simply involved its reduction to powder by decrepitation, and its resolidification by compression. According to Malo, it is the same impregnated rock in the street that it was in the mine. It is, therefore, capable of being again "decrepitated" in the street by the application of the same necessary degree of heat, precisely as it was before being first reduced to a powder, preparatory to laying.

The other variety of French pavement, there known as "asphalt mastic," is a compound of which powdered rock asphalt is the

principal ingredient. For commercial purposes there is made an intermediate product, going under the commercial name of "mastic," in which, say, ninety (90) pounds of rock asphalt powder is mixed under heat with, say, ten (10) pounds off bitumen. This sub-compound is poured from the heating vessell, in a pasty condition, into molds, " where it is left to cool, and forms solid blocks, " weighing about fifty-five (55) pounds." In this form it " is ready for sale and transport to all places." The words in quotation last above are taken from page 13 of Defendants' Exhibit Beckwith Article (D). I further quote from the same page as follows:

488 " Bituminous Sidewalks.

" Bituminous sidewalks cover in Paris a surface of 1,430,896 square yards. They are made of asphalt, with an addition of bitumen and gravel, in the following proportions:

Mastic ..... 100 pounds.
Additional bitumen .....5 to 6 pounds.
Fine gravel .....60 to 70 pounds."

On the following page in the same exhibit publication are cuts illustrating sidewalk pavements made from this mastic compound, the asphalt mastic coating being thereon marked as three-fifths (3-5) of an inch in thickness. The mode of preparing and applying this sidewalk covering is given in the text in part as follows:

" The temperature in mixing should range from 300 degrees to 400 degrees for two or three hours, the mass being all the while agitated, * * * when the mixture will be ready for use."

" Transportation.—It is then drawn off into a portable sheet-iron boiler on wheels supplied with a small furnace and revolving shafts and spokes; a moderate fire is required on the way to keep the mastic in a semi-liquid state, and the shaft is occasionally turned by hand to avoid the unequal heating of the mastic.

" Laying.—To secure uniformity and facility in spreading the mastic on the bed, a couple of iron rods or rules are used of the thickness of the intended coat, usually three-fifths of an inch. These are laid across the sidewalk parallel to each other, * * * thus forming a gauge for the workmen. The mastic being of the consistency of ordinary mortar and brought hot from the portable boiler in an iron ladel (see Plate CCC, Fig. 16), is dumped on the ground in small charges between the rods and is immediately spread over the surface with wooden trowels. (See Plate III, Figs. 14-15.)

" One belt being thus laid, another is commenced while

489 the first is still hot; the edges of the first and second belt, if kept clean, will readily unite, and the work is then continued.

"The surface of the coat being smoothed by wooden trowels, a light shower of light, dry sand is sprinkled on it while it is still soft, to produce a more stony surface, but, the mastic being already saturated, very little of the sand will be retained.

"The cooling and hardening are rapid, and in a few minutes the sidewalk is ready for use."

The sectional sketch on page 15, which is there said to "represent the disposition of the mastic next to the wall and the curbstone," shows the mastic abutting against the inner vertical surface of the curbstone and flush with the latter at its top. At the inner margin of the sidewalk the mastic is plastered against the vertical wall (of a house or other building) to the height of two or three inches, apparently.

It will be observed that no pressure is applied to this mastic in coating the sidewalk foundation therewith. It is simply spread upon the foundation with a trowel, as mortar is spread upon a wall, and when cool is ready for immediate use. It is thus evident why the terms "compressed asphalt" are employed to distinguish the roadway pavement described, which is solidified only by compression.

In considering the Crochet patent a little later I shall have occasion to point out that it evidently relates mainly to "compressed asphalt pavements," as technically known by that name in France, and that in its concluding sentence (preceding the claim) it relates alternatively to this more bituminous half-inch mastic coating for sidewalks. In order that there shall be no doubt that
490 the Crochet patent does have reference to these several French asphalt pavements I make other citations from the defendants' exhibit publications.

In the translation of "Malo Article No. 1" (B), page 6, the subject of rock asphalt is introduced in these words:

"Regarding bituminous limestone or '*asphalt*,' properly so called, the most rare of the manifestations of bitumen, this is a rock formed of 90.94% of pure carbonate of lime and of 10.6% bitumen. Its aspect is that of plaster stone, its color that of dark chocolate; * * * the grain is fine, and when the structure is attentively examined it is seen that each molecule of lime is surrounded by an almost atomic coat of bitumen; every grain is thus isolated from its neighbor by

a varnish which serves at the same time to glue them energetically to one another. * * *"

"2." *Extraction—Pulverization—Sifting.*—Asphalt is obtained after the manner of masonry stone with [blasting] powder and tamping-iron.

"The asphalt rubble is piled upon the floor of a mine; * * * a part is forwarded to the public works in the state of rock, the rest is sent to the factories for the fabrication of mastic. There is need ordinarily to avoid great production during summer, since heat causes the rock to decrepitate, which tumbles—of itself—into powder.

"Rock destined for the making of mastic is crushed, then pulverized.

"The crushed bituminous limestone is thereafter sifted.

"The pulverization can be effected in two ways: hot, by decrepitation; cold, by grinding.

"* * * The following phenomenon is produced [in hot pulverization]: The bitumen with which the rock is impregnated—solid at ordinary temperature—softens and flows; the calcareous molecules separate from one another and tumble into powder; * * * the material thus treated (shocked) is then thrown upon a flat place, where it is stamped
491 in order to accomplish the pulverization. * * * The powder obtained is ready to be transformed into mastic.

"Decrepitation is also produced in special apparatus, of which we will speak apropos the streets of compressed asphalt rock.

* * * * * * *

"However, the powder employed in establishing compressed streets is obtained up to the present time by decrepitation."

After an extended description of the manufacture of asphalt mastic the article on page 12 takes up the subject of compressed asphalt roadways, beginning with the following heading;

"1. *Application of raw asphalt. Compressed asphalt road ways.*"

Adjourned to Monday, October 31, 1898, at 10 a. m.

Chicago, October 31st, 1898.

Met pursuant to adjournment.

Parties present as before.

(Mr. Dayton continues his answer):

Under this heading is first related the accidental manner in which "compressed asphalt roadways" first came to be known.

This account also explains and justifies the use of the word "compressed" in this connection. The author says:

> "* * * The carts which transported the rock from the mines to the places for treatment would often let fall upon the road some fragments which the wheels crushed; when the route was covered with the debris, summer supervened, the heat softened the bitumen of impregnation, the wagons which followed on compressed the material and there was formed a crust—solid, dense, elastic, easy to the feet of the horses and of almost no wear."

In 1850 "this lesson of chance was voluntarily put to profit" by a Swiss engineer named Merian, who, at this period, at the
492 Village of Traverse, built "a roadway from heated and compressed rock." "At length," the author says, 'the street of compressed asphalt obtained its entry into the compulsory theater for all serious trial. It penetrated into Paris. * * *"

> "This is how one proceeds in the installation of compressed asphalt streets: The asphaltic rock extracted from its deposits and broken to the size of pebbles which served for metal of macadamized routes is decrepitated as we have before indicated, but in special apparatus * * * transported to the working spot or to a place near by in order that the decrepitated powder shall lose the least heat possible. The body of the street has preliminarily been covered over with bed of beton. * * * Upon this beton, well rammed, * * * is spread the decrepitated material that is tamped and of which a bed is made from 0.04 or 0.05 m. [roughly, an inch and a half to two inches], according to the circulation [travel] which it needs to support.
>
> "The compression is next regulated by moving over the surface a roller of 2,500 to 3,000 kilogr. weight; [roughly, 5,500 to 6,000 pounds]; two hours later the street can be open to vehicles."

Defendants' Exhibit Beckwith Article starts out with the heading:

> "ASPHALT AND BITUMEN, AS APPLIED TO THE CONSTRUCTION OF STREETS AND SIDEWALKS IN PARIS."
>
> "Introductry Remarks."
>
> "Asphalt is used in Paris chiefly in two different forms: first, the natural rock, unalloyed, with which *streets* are

made; second, a mixture of asphalt with bitumen and fine gravel for the construction of *sidewalks*.

* * * * * * *

"The mixture above spoken of is called mastic of asphalt and is manufactured in many places in France. * * *

493 "The term 'asphalt' or 'asphaltic rock' is applied only to a species of limestone impregnated with bitumen.

* * * * * * *

"'Mastic or asphalt' is a composition formed of bituminous limestone (asphalt) reduced to powder and mixed with a small quantity of bitumen.

"This mastic, with a further addition of bitumen and fine gravel, is used for *sidewalks*.

From these "introductory remarks" of the "Beckwith Article" it is evident that by the term "asphalt" the French understand the natural rock which is impregnated with bitumen and from which "compressed asphalt pavements" are made for roadways for vehicles, and that by the term "bitumen," employed in connection with pavements, is meant "mastic of asphalt" reduced to powder and mixed with an additional amount of bitumen and with fine gravel for use upon sidewalks. The general heading of the Beckwith Article is clearly to be understood as though the word "respectively" were introduced, as follows: "Asphalt and Bitumen, as Applied to the Construction of Streets and Sidewalks, *respectively*, in Paris."

This inference finds further warrant from other portions of the same article. The term "asphalt" is throughout the article used synonymously with "asphaltic rock." "Asphalt streets and roads" are described as being made of such asphaltic rock, "unalloyed," decrepitated to powder by a specified degree of heat, spread on a foundation and "pressed or packed * * * and allowed to cool," so as to "solidify, forming a monolithic crust, identical in "all respects with the primitive rock, as if it had been taken in "that form from the original bed. Such is the principle on

494 "which roads of compressed asphalt are made." A detailed description of the manner of constructing "compressed asphalt roads" is concluded with the following paragraph:

"The use of compressed asphalt is not limited to the construction of roadways. Courtyards of railway stations, hotels, private houses, quays and crossing for foot passengers from one sidewalk to another, are often paved with compressed asphalt. * * *"

Later, on page 12 of the Beckwith Article, appears the heading, "Mastic of Asphalt," and under this heading the article says:

> "The substance known by the name of mastic of asphalt, *of which sidewalks are made*, is composed of asphaltic rock reduced to powder and mixed with bitumen, to which may be added sand or gravel."

On the opposite page (page 13) appears the heading, "Bituminous Sidewalks," under which heading appears the formula for sidewalk coverings already given in an early part of this answer. Under this heading also appear the cuts and description before referred to as showing the bituminous covering of mastic to be "3-5 inch" in thickness.

Defendants' Exhibit (F) Chabrier Article further supports my above expressed understanding of the terms employed in French literature pertaining to the art of pavements. On page 280 after the statement that "asphalt is quarried like limestone, * * *" and under the heading, "Pulverization," this article says:

> "Asphalt blocks must be pulverized before being used, and for this operation several processes have been tried.
>
> "1. *Decrepitction*, or breaking up, takes advantage of the peculiar qualities asphalt possesses of fusing, by the softening
495 of the bitumen which holds together the limestone molecules. In the early stages of this process the asphalt was placed on heated iron plates called '*decrepitators*.' * * *"

One page 281 is the heading "II. Compressed Asphalt." And under this heading is given a description of the laying of the powder of asphalt rock, while under subheads are described different means for effecting "compression." "Compressed asphalt" are terms which frequently occur in this second division of the article and always in connection with "roadways" as distinguished from "sidewalks," although on page 286 occurs the following passage indicating its use in other situations, some of which, however, are still subject to travel of horses and vehicles:

> "Compressed asphalt, moreover, has been successfully applied for courtyards and for interior of houses where the thickness need not exceed 1 1-4 inch as the duration appears to be unlimited. In Paris, the courtyards of the Grand Hotel, the Hotel Louvre, the new opera house and of a large number of private establishments * * * are thus treated, and horses never stumble in such instances, for the asphalt is always kept clean."

On page 289 appears the following heading of the third division of the article, "III. Asphalt Mastic." Under this heading appears the following statements relating to the use of this substance:

"Mastic asphalt has all the qualities of cement for uniting building materials, but the author confines his attention to its application in making *footpaths*.

* * * * * * *

"For a long time Seyssel mastic was made with pure bitumen extracted from the soft stone, and for re-melting the
496 mastic when laying the *footpaths* Bastennes bitumen was obtained by the washing process as long as the same lasted.

"The chief quality required for bitumen used for *footpaths* is the retention of the pasty appearance under the influence of great variation of temperature.

* * * * * * *

"The employment of asphalt mastic is considerable.

"* * * The layer of mastic possessing no resistance in itself and being simply a carpet, necessitates the consolidation of the soil, which is ordinarily done by concrete, the surface of which is floated with mortar.

"* * * A layer 1 centimeter (0.39 inch) in thickness will give, theoretically, about 50 pounds weight per square meter for practically 56 pounds per square meter (46 pounds per square yard).

"* * * A skilled workman can * * * lay from 120 to 150 squares meters (140 to 180 square yards) in a day, 15 millimeters (0.6 inch) thick."

The foregoing concluding quotations indicate the thickness of the mastic coating for sidewalks to be from 0.4 to 0.6 of an inch. Other thicknesses and other uses are indicated in the following paragraph:

"The thickness generally used for footpaths and for public building is 15 millimeters (0.6 of an inch). * * * For railway stations, where there is good traffic, 2 centimeters of mastic * * * is generally adopted; and for passages and entrances subject to heavy carriage traffic [by which I understand to be meant alley and entrance crossings of sidewalks] about 4 to 5 centimeters (1.6 inches to 2 inches) is used."

"* * * For roadways mastic asphalt has been generally abandoned in favor of compressed asphalt rock, which is homogeneous in texture."

"* * * But it is certain that asphaltic mastic on *footpaths* will bear for a long time a considerable traffic of passengers.

497 "In Paris, under the arcades of the Rue de Rivoli, of a mastic sidewalk laid in 1845, and which was not relaid until

1868, there remained a thickness of 3 to 4 millimeters (0.12 inch to 0.16 inch), which was removed in large sheets.

* * * * * * *

"In ordinary conditions, a duration of fifteen years may be reckoned upon. This basis has been adopted for a system of maintenance for more than twenty (20) years in Paris for the *footpaths*."

The remaining publications introduced by defendants harmonize with the foregoing in recognizing two distinct kinds of French asphalt pavement, and in distinguishing them in the same way as either "compressed asphalt" or as "bituminous" or "asphalt mastic." *Nowhere in these publications is there shown any knowledge of the American asphalt pavement or of the American "asphalt mixture."*

With the enlightenment on these points received from the exhibit publications it becomes easy, on taking up the Exhibit Crochet Patent, to understand to what it has reference.

First, as to this title, namely:

"For a process for the reparation and recharging of compressed asphalt roadways."

This can plainly mean only roadways of *rock asphalt*, reduced to powder and solidified upon a suitable bed by *compression*, as the various publications referred to describe.

The statement of invention is consistent only with this conclusion:

"It consists in reheating the part to be mended by means of a movable furnace, which the operator shifts about at the surface of the roadway *until such portion decrepitates and becomes friable*. The upper portion of the layer of asphalt and that which has been damaged are taken off by means of an iron scraper armed with small teeth which perform the office of a rake; said scraper in raising the material forms at the same time upon the part remaining numerous striae, which render the surface wrinkled and augment the adherence of the additional over-thickness which constitutes the recharge.

"The *repeated* passage of the movable furnace thereon has equally for its effect to vaporize the water and the humidity which are found in the asphalt pavement at the portion to be repaired or recharged.

"After this preparatory operation, the workman spreads a convenient depth of asphalt in *powder-like state* and *stamps* it by the ordinary means; because of the softening of the sub-

jacent layer sa.d layer solders itself perfectly to the new coat and forms wit. it a thickness without break in continuity."

After a description of the movable furnace employed the specification concludes with the following sentence:

"This system, especially applicable for streets of compressed asphalt, can be equally employed to repair and recharge streets of bitumen."

It is evident, I think, that this last above quoted passage from the patent, in its final words, "streets of bitumen," as certainly refers to the *bituminous or mastic coverings of sidewalks* as the title and main body of the specification refer to the *compressed rock asphalt coverings of roadways.*

This much determined, I proceed to consider the character of the Crochet heating apparatus with reference to the manner in which does its work. This apparatus is illustrated by drawings, and is described as follows:

"* * * It is composed of a box body, the sides A, A,
499 B, B, of which are perforated throughout, and the bottom C whereof is formed of a grating below which there is a metal plate D *to radiate the heat* over the surface of the asphalt. Said plate D is movable to allow for the withdrawal of cinders. The box is mounted upon the wheels E, the axes *a* thereof are adjustable upon supports *a* the elevation of which in guides *b* can be varied to augment or diminish the distance from the box to the roadway. A handle F serves to manoeuvre the car over the pavement."

We have learned from the Defendants' Exhibit Beckwith Article (D), page 5, that rock asphalt "at the temperature (F) of 140° or 160° commences to disintegrate and crumble. Above 212° the disintegration is complete." It is therefore to be understood that 212° Fahrenheit, or little more, is the temperature imparted *by radiation from the plate* D below the fire-grate of the furnace, to the asphalt at and adjacent to the surface of a rock asphalt pavement, under the Crochet patent. Indeed, this may be understood to be the temperature prescribed in the patent in view of its statement that "the part to be mended" is to be reheated "until such portion decrepitates and becomes friable."

The patent does not specify to what condition the bitumen or mastic pavement is to be brought in applying the "system" to its repair, as proposed in the single sentence quoted, but it is manifest that the mastic cannot be reduced to a powder or made "friable" by the same heat, or by continuation of its application for the same length of time, that suffices to "decrepitate" the rock

asphalt. Hence, it is left for inference, perhaps, that in applying the method to a bitumen pavement or sidewalk surface, the
500 heating to be employed for the sole purpose of softening the mastic coat enough to facilitate its removal and thus to obviate the danger of "the starting of the adjacent portions which are sound, swelling them up in such wise that in the end of a little it is necessary to repair them in their turn," as the patent says was the case in removing the rock asphalt "with a pick." Obviously, the softening of the old mastic sidewalk covering for the sole purpose of its removal need not be carried to the extent to which the new material to be added is to be softened, for the latter is to be made, by heat, of the consistency of mortar, which requires that it be maintained at a temperature of 300° to 400° F. The Crochet patent is, therefore, quite indefinite as to the condition to which the bitumen or mastic sidewalk surface is to be reduced in the proposed application of the "system" of the patent to sidewalk repair.

Again, while the patent is clear in stating that, in applying the system or method to pure rock asphalt pavements, the decrepitation and removal of old material "is independent of the depth of the asphalt layer" (which means that only part, in depth, of the asphalt layer need be decrepitated and removed), is silent on this point respecting the mastic or bitumen footpath covering. This is usually only 2-5 to 3-5 of an inch thick and, as we have seen, often wears to much greater thinness. If we may fairly understand the patent to refer to this usual sort of bitumen footway pavement, it is hardly, I think, to be supposed to contemplate the removal of only a portion of this thin pavement, as it does of only a portion of the many times thicker unalloyed rock
501 asphalt pavement. Besides, it would evidently be so difficult to divide so thin a coating as to be impracticable, if that were the contemplation of the patent.

Of course it is not contemplated by the patent that the "mastic of asphalt" or new material for the sidewalk repair shall be applied to the excavation "in powder-like state," or that it shall be compressed therein "by the ordinary means," but, on the other hand, it is, of course, expected that the new material will be introduced at the consistency of mortar and spread with a wooden trowel, as in laying original bitumen pavements.

Hence, it appears to me this single indefinite reference of the patent to "bitumen" or mastic footway pavements may fairly be taken to mean nothing more than a proposal to soften the mastic footway covering to facilitate its practically complete removal at

the place to be repaired in obviation of the disadvantages to the surrounding pavement resulting from the previous practice of chopping it out.

Adjourned to Tuesday, November 1, 1898, at 10 a. m.

Chicago, November 1, 1898.

Met pursuant to adjournment.

Parties present as before.

(Mr. Dayton continues his answer):

I consequently regard the "Defendants' Exhibit Crochet Patent" as being a definite disclosure or statement only of "compressed asphalt" pavement repair. As to what was in the patentee's mind concerning pavements of mastic or bitumen, 502 the patent, as it seems to me, is vague, incomplete and insufficient.

Several of the defendants' exhibit publications refer to a mode of repairing "compressed asphalt" pavements similar to that set forth in the Crochet patent. None of them suggests or describes the application of a similar mode to the repair of mastic pavements.

While the Crochet patent affords the fullest and most complete description of the mode of repairing compressed asphalt pavements, so that the less complete descriptions given in the other exhibits might be disregarded, I nevertheless quote briefly from said publications as follows:

The "Malo Article No. 3" (G), on page 3 of the translation, says:

> "* * * We have recently pointed out a more rapid remedy, much more economical, and which—put in practice the last year—has succeeded perfectly. It consists simply in covering the depression with a heated sheet metal plate of 10-12 millimeters thickness (say, 3-8 to 1-2 inch) that is placed at a few centimeters height above the ground; at the end of a few minutes the heat of the plate softens the asphalt about 1 or 2 centimeters (say 3-8 to 3-4 inch) in depth. Then the surface is raked to remove the dust (the powder to which the pavement has been reduced by heat to that depth) therefrom and lay bare the pure asphalt; next, new and warm powder is sprinkled over in quantity sufficient to fill up the depression, and is tamped energetically. The two powders solder together perfectly and separate no more. Some repairs of this sort made a year ago under our counsel on the asphalt streets of Lyons have caused the depressions

to disappear in a complete manner; traces thereof have never been seen again."

503 (The original of the above-mentioned article bears date 1879.)

The translation of "Defendants' Exhibit Malo Book" (I), dated 1888, speaking exclusively of "compressed asphalt" pavement, on page 3 says:

"In a small rolling furnace, an iron plate of 10 to 12 mm. thickness is heated which is placed over the part of the street to be repaired. The heat of the plate softens the asphalt layer, which can thereupon be scraped and removed to the depth necessary in order that every source (germ) of deterioration shall be extirpated. While the wound is still hot there is spread thereon a layer of fresh (new) powder, which is tamped down until it has taken exactly the level of the street. At the end of an half hour the operator can throw the piece (site) open to circulation.

"This mode of repair is also employed very efficaciously for the rectification of sunken spots often found at the surface of compressed asphalt without the latter ceasing to be sound because of them. These spots, which are due for the greater part of the time to an unequal distribution of the powder at the moment of laying, can be sufficiently deep to form in rainy weather small lakes, slow to dry and disagreeable for pedestrians. It is simply requisite to reheat by means of the red hot plate of which we have spoken the depressed surface in order to soften and render it proper for soldering (welding). The spot is raked lightly, next there is spread over it the necessary quantity of hot power so that after tamping the depression may be filled up. The soldering is then perfected and the sunken spot has disappeared."

I repeat that I nowhere find in any of defendants' exhibit publications, either prior to or later in date than the Crochet patent, any description of the application of that or similar methods to the repair of mastic pavements, or any description of any method of repair for such mastic pavements which helps to a bet-

504 ter understanding of Crochet's indefinite and incomplete reference to the repair of such pavements.

Now, comparing the disclosures of the Crochet patent with those of the Perkins Method patent No. 501,537 in suit, it is first to be observed that the materials operated upon are widely unlike in their composition or structure, and in the phenomena developed therein under particular, corresponding conditions of temperature and pressure

Both materials, indeed, form a pavement; both, in general terms, are hard when cold, and yield when hot and become solid when cooled after compaction. In both, moreover, bitumen enters as a means for uniting the solid lithic elements thereof. But the distribution and composition of the lithic with the bituminous elements are very dissimilar. In the rock asphalt these substances are molecularly distributed and united so as to form essentially a single substance, while in the American asphalt "mixture" the sand grains are unimpregnated, and constitute severally independent and relatively large bodies which the separately combined bitumen and residuum oil merely serve to cement together. The limestone flour introduced into the mixture occupies with the cement the interstices between the sand grains, and serves to stiffen the cement to better enable it to hold the sand grains in place and prevent movement thereof among themselves.

Agreeably with this difference in constitution, while there is *softening* of the cement of the American mixture under heat, there is nothing corresponding to the powdering or "de-
505 crepitation" of the natural rock asphalt when heated to softness. The reduction of the American "asphalt mixture" to powder is ruin to it (calling the sand grains "powder"), because such reduction would involve the practical elimination of the cement. Wherefore, after being once reduced to powder by destruction of one of its elements, it would be incapable of reunion and consolidation. Hence to attempt to follow literally the instructions of the Crochet patent in operating upon an American asphalt mixture pavement would be impossible or ruinous. Such American asphalt mixture cannot be "decrepitated" by following that patent, and, if it could be, it would be destroyed.

What is wanted in the preliminary step of the repair of the American pavement is the softening of the solidified cement which unites the sand grains—not disintegration of the sand grains themselves; for in solidified American pavements the sand grains exist as bodies or masses as they did upon the beach from which they came, and they are only held in place in the pavement by the solidified cement. The pavement is not a continuous and homogeneous "rock," but it is a heterogeneous conglomeration of sand grains and interposed cement.

It is by reason of these structural differences in the pavement materials themselves that decrepitation or reduction to powder of one of them is produced, and is completed at the comparatively low temperature of 212° F. (as stated by one of defendants' pub-

lication exhibits), and that it may be compacted and solidified at a much less temperature to its original state of a continuous rock; while the other is semi-liquefied by heat, and requires
506 a much higher temperature for its semi-liquefaction and subsequent compaction. The testimony shows that the American "asphalt mixture" is perfected at a temperature of 350° F., and that it is laid on the street at nearly this temperature. The Chabrier Article says (top of page 290) that while rock asphalt or "bituminous limestone heated to between 212° and 300° "Fahr. loses its consistency and is reduced to powder. If the "heating be increased, the powder does not melt but the bitumen "is evaporated, leaving the limestone, when at a red heat, per-"fectly pure." Hence high temperatures are not applicable to rock asphalt as they are to the American "asphalt mixture." It is only when rock asphalt is combined with an additional quantity of bitumen, as in making asphalt mastic for footways, that it is subjected to a temperature corresponding with that required to be applied to the American mixture for the proper manipulation of that mixture.

It is, also, by reason of the constitutional differences between rock asphalt and the American "asphalt pavement mixture," that entirely different phenomena follow the compression of these materials upon a roadway. In the case of the American mixture tamping and rolling at the temperature of 300 or 350 degrees results in mere compaction. That is to say, the sand grains are merely forced into such adjustment with each other as to bring the mass into the smallest compass. The solidification occurs only in the cement occupying the necessary interstices between the sand grains, and this solidification results from its cooling. In the case of the rock asphalt powder, on the other hand, molecularly impregnated with what one of the authors has called
507 an "almost atomic" "varnish" of the bitumen, covering all the molecules alike, compression forces the varnished molecules together and *reproduces the original limestone rock*, as it existed in the natural deposits from which it was taken.

From the foregoing it would appear that the constitutional differences between rock asphalt and the American asphalt pavement mixture may *demand* different methods of treatment in the repair of pavements made from such materials respectively, at least as to the temperatures employed upon the surfaces of the different pavements for the decrepitation of one and the semi-liquefaction of the other.

This brings us to a comparison of the Crochet and Perkins

methods as effected or determined by the different modes of action, if any, pertaining to the different apparatuses set forth in the respective patents.

The Crochet patent proposes the employment of a fire box having a grate bottom, and containing (we will assume, as most favorable to the patent and device), a body of live coals. At some little distance below the grate is supported a sheet metal plate which, in turn, is held a little above the surface of the pavement. The plate is heated by radiation from the coal fire on the grate and the surface of the pavement is heated by radiation from the plate. The heat which reaches the pavement is, therefore, a secondary radiation from the coals. We have heating stoves which contain coal grates, in front of which doors may be closed when the radiation from the coals gives too much warmth in the room. From these stoves we may obtain an idea of
508 the degree of heat likely to be imparted to the surface of the pavement by the Crochet apparatus, acting upon the principle of secondary radiation. Manifestly, such heat at the pavement is of relatively low degree. In this respect it may possibly be suited to the decrepitation of rock or compressed asphalt, which, as we have learned, requires for this purpose to be heated only to the temperature of boiling water, and especially may it possibly serve for that purpose if, as the Crochet patent says, the "passage of the movable furnace" over the pavement to be "repeated" enough times, and for a sufficient length of time. (There is a doubt, however, of this, as will later be seen.)

This is not the mode of operation of the apparatus set forth in the Perkins Method patent. This Perkins apparatus employs a flame *blast* sent directly and continuously against the surface of the pavement to be softened. The heating is effected, therefore, by direct "*transmission*" from the flames to the pavement and not by "*radiation*" or secondary radiation, as directed in the Crochet patent. The heat of the flame blast proposed in the Perkins method is manifestly far more intense than any heat which can be radiated from the interposed plate of the Crochet device, and, as "transmission" of heat is far more rapid than "radiation" or "convection," the Perkins method involves the imparting of a much higher degree of heat to the pavement surface and at a much more rapid rate than is possible with the apparatus described by Crochet. But the action in heating the pavement by the method set forth in the Perkins patent is to heat neither too much nor too rapidly—*for the American asphalt pave-*

509 *ment.* Beneath a thin, stiff crust formed by the Perkins method where the blast flames directly impinge, the asphalt mixture is uniformly softened to any desired depth or shallowness, regulated by the time during which the flame blast is continued thereon. The high heat liquefies the cement and the "mixture" re-acquires and presents the softness and semi-fluidity which it possessed when originally laid. Notwithstanding the high and direct heat, the material is not burned, being protected by the paper-like crust formed thereon, and after the removal of this crust (its removal is desirable and is accomplished by raking it off, accompanied by a little of the material immediately below it) a softened, loosened and rough surface of old material is presented for union with the new, in which old material the cement is apparently as lively as in the new, so that the two may unite with an indistinguishable union.

It appears to me that the difference between the Crochet and the Perkins modes of applying heat to the pavement, irrespective of the difference between the pavements themselves, is to be regarded as an essential difference between the two methods of repair, considered as entireties, and that the Crochet patent is not an anticipation of the methods set forth and claimed by Perkins. It is perhaps unnecessary to have expressed this last opinion, since, as I understand the fact, said Crochet patent is not offered as an anticipation of Perkins, but solely as a part of the prior art.

In my judgment, said Crochet patent is either an anticipation of Perkins or it is nothing to the Perkins method. It either proposes what Perkins has accomplished, or it proposes what
510 would fail to accomplish Perkins' purpose. Falling short of Perkins' attainment on American asphalt pavement, whether a success or not on compressed asphalt pavement, it seems to me to stand rather as a discouragement than as an aid to the progress that Perkins made.

But I find in defendants' publication exhibits of the prior art what I regard as evidence that the Crochet method was not practicable even upon compressed asphalt pavements. Malo seems to have been the highest authority on this subject of asphalt pavements. In the Malo Article No. 3 (G), Malo, as already quoted, describes what has been tried for a year in 1879. This consisted "simply in covering the depression with a heated "sheet metal plate of 10-12 millimeters thickness that is placed "a few centimeters height above the ground; at the end of a few "minutes the heat of the plate softens the asphalt about 1 or 2

"centimeters in depth. Then the surface is raked to remove the "dust [powdered asphalt] therefrom and lay bare the pure as- "phalt; next, new and warm powder is sprinkled over in quantity "sufficient to fill up the depression and is tamped energeti- "cally."

In 1888, eight years after the Crochet French patent was taken, this same Malo, in his French book, "Defendants' Exhibit Malo Book" (I), says, as also before quoted, that the thing to do and that has been done "now for several years with complete success" was to heat "red hot" in a "rolling furnace an iron plate from 10 to 12 millimeters thickness," and to place this red hot plate "over the part of the street to be repaired." He does not say whether or not the plate is to be sustained at a distance
511 above the surface of the pavement, but says only that "the "heat of the plate softens the asphaltic layer, which can "thereupon be scraped and removed to the depth necessary in "order that every source (germ) of deterioration shall be extir- "pated. While the wound is still hot there is spread thereon a "layer of fresh (new) powder, which is tamped down until it has "taken exactly the level of the street."

The above quotation is taken from the middle paragraph of page 3 of the translation. The red heat of the plate is referred to in the next paragraph in the sentence reading as follows: "It is "simply requisite to reheat [the compressed asphalt] by means "of the *red hot* plate of which we have spoken. * * *"

Not only is no mention made of the then eight-year-old invention of Crochet, which, if it had merit, should then have been known and in use, but an entirely different means, and one having manifestly far more potency than the secondary radiating plate of Crochet's device, is specified for heating and decrepitating the pavement. This different means is a thick "red hot plate of iron" heated to redness in (not under) a portable furnace, and then taken from the furnace and "placed over the part of the street to be repaired." The fair inference from this article is, I think, that Crochet's apparatus, necessarily known, was known as a failure, and that his "system" as a whole, new only as to the apparatus and its peculiar mode of action, was a failure.

But whether practicable or not upon a rock asphalt pavement, the Crochet apparatus is, in my opinion, impracticable upon American asphalt pavements.

512 It must be conceded that, at least as to *compressed asphalt* pavements, it was old in general terms to soften the upper portion of an asphalt pavement by heat, to remove a por-

tion or practically the whole of the softened material and to apply new material to fill the cavity at the date of the Perkins Method patent.

Notwithstanding this is shown by the record clearly to have been done only upon rock asphalt or "compressed asphalt" pavement, and is not shown to have been done upon American "asphalt mixture" pavements, or by any one indicating a knowledge of the existence of American asphalt mixture pavements, such prior art may possibly be regarded as having a bearing upon the method described and claimed by Perkins. If so, it is still plain that Perkins' method is characterized by a new and useful way of applying the heat to the pavement, to wit, *by sending a flame blast into direct contact with the pavement surface.* This feature of Perkins' method is, in my opinion, not anticipated by the radiation of heat to the pavement from an iron plate, either previously heated by embedding it in the coals of a furnace or heated by its interposition between the horizontal fire grate of a furnace and the pavement surface. Wherefore, regarding the Perkins method as distinguished by his different, more expeditious and more effective *way of applying heat*—to say nothing about any higher degree of heat finally imparted by his method, and nothing about the difference in material upon which the old and new methods have respectively been practiced---I regard the Perkins method as essentially new and as being unaffected by the disclosures of the prior art in this record. I believe Perkins made an in-
513 vention over the prior art for which he was entitled to the patent he received.

It is a stated object of the Perkins invention that it "is de-
" signed to produce a method whereby the repairing of asphalt
" pavements may be *quickly* and *cheaply* accomplished," as well as whereby "a neater appearing pavement (may) be obtained after
" repairing." There is, in my judgment, no question that, by this Perkins method, repairs may be effected more "quickly and cheaply" than by any method disclosed in the prior art, *because* of his application of the heat to the pavement by blast flame contact. There is no slow operation by radiation, and there is no delay occasioned by the heating of a plate in a furnace, nor is there any such delay and trouble as must attend the handling of such a plate. Nor is there delay and expense due to the establishment of a thoroughly incandescent coal fire, nor such inequalities of heating at different points as accompany a coal fire resting upon a grate or over a radiating plate, due to the deposit of ash or to unequal incandescence.

The feature of Perkins' method is not dependent upon a particular apparatus. The patent so states, and, as a matter of fact, different and improved "forms of apparatus," affecting the efficiency of the method, have since been devised. These all retain the obviously best idea of using a liquid fluid, but this is not essential to a flame blast and, of course, not essential to contact of the flame with the pavement surface. Hence, in my judgment, it would not be correct to say that the invention is one of apparatus and not of method. The method seems to me complete in itself, independently of particular apparatus.

514 Adjourned to Wednesday, November 2, 1898, at 10 a. m.

Chicago, November 2d, 1898.

Met pursuant to adjournment.

Parties present as before.

In connection with the non-limitation statement of the Perkins patent concerning the "form of apparatus for carrying out "my (the) invention," it is to be observed that the patent shows and describes only a kind of apparatus which gives a flame blast and directs the flame into contact with the surface of the pavement. In other words, the Perkins patent and the method therein set forth contains the idea of heating the pavement on the principle of "transmission," as distinguished from "radiation" and "convection," the three recognized principles of heat transference. It may be added that the patent is the first disclosure in the art of any apparatus by which heat may practically be imparted to an asphalt pavement on this principle. In this remark I exclude the building of a wood fire on the pavement since, by reason of its varying intensity at different points and other obvious considerations, it is unsuited to the economical repair of the asphalt coating, though perhaps suited to the mere softening of the asphalt when its entire thickness is to be removed and thrown away. The flame contact is cleanly, economical, expeditious, uniform and perfectly governable. It is, therefore, distinctly practical and advantageous, both mechanically and commercially. If the court cannot find in the difference between the American and the French asphalt pavement materials sufficient ground for

515 recognizing patentable novelty in the Perkins invention over the prior foreign art, it seems to me said Perkins' method is amply distinguished from such prior art by its mode of heating the pavement on the principle of "transmission" by flame contact, without regard to the "form of apparatus" by which such flame contact may be effected.

Summarizing, in my opinion, the method set forth in the Perkins patent for the repair of American asphalt mixture pavements is distinguished from the prior art disclosed in defendants' exhibit publications and Crochet patent, first, by the dissimilarity in the nature and phenomena of the materials operated upon, considered in connection with the different requirements of such materials—the prior art making no adaptation of its methods to the American mixture pavement—and, second, by the conspicuous difference in general mode involved in the particular method of applying heat to the old surface material of a pavement as the first step in the operation of repair.

Q. Have you examined the record in the suit of United States Repair & Guaranty Company et al. v. Standard Paving Company, recently decided by Judge Coxe, of the Second Circuit, and have you also read his decision and opinion in that suit?

A. I have.

Q. 7. I quote the following from Judge Coxe's decision in that case, noting that he throws out all other defenses than the Crochet patent:

"The contention of the complainant's expert is that the words 'asphalt pavement' must be read 'rock asphalt pave-
516 ment,' and the words 'pavements of bitumen' indicate 'another class of rock asphalt pavements.' Various words and phrases are pointed out as supporting this theory. For instance, Crochet says that the use of the pick causes the neighboring portions to be 'puffed up,' that after heat is applied the surface of the pavement 'disintegrates and becomes friable,' and that 'asphalt in powder' is spread upon the part to be repaired. Wrested from the context these expressions might indicate that Crochet had in mind a different material from that described in the patent at bar, but considering the Crochet patent as a whole, it cannot be limited to a method of mending country roads.

"Imprimis, Crochet resided in Paris, a city long pre-eminent for the excellence of its pavements. In the absence of positive proof by witnesses qualified to testify of the progress of the art in France, the court would hardly be justified in assuming that Parisians were ignorant of a pavement which has been in use for a quarter of a century and in 1880 were well known even in the interior cities of this country. The patent makes no allusion to country roads, but again and again refers to 'asphalt pavement.' It speaks of the 'layer of asphalt,' and the drawings, though crude, show a layer of asphalt up-

on a bed of concrete similar to the pavement as it exists to-day and as it has existed in this country since 1870. The heat 'softens' the upper surface, the teeth make grooves in it, and the new asphalt adheres to the old without joint or seam. Finally the patent says that the system, 'though especially applicable to pavements of compressed asphalt, can be used to repair and renew *pavements of bitumen*.' All this is incompatible with the theory that Crochet was dealing with a substance which has been reduced to a dry powder, and indicates beyond a fair doubt that if he had not in mind the same material that Perkins describes in identical language, it was at least an equivalent material having the same attributes and properties and producing the same result when subject to
517 heat. The language used by Crochet may be infelicitous in some particulars, but that he describes a process for mending asphalt pavements by heating, raking and compacting there can be no doubt.

"The complainant's expert speaks of the asphalt of the Perkins patent as being 'compressed.' Obviously, then, a Trinidad asphalt pavement is a 'pavement of compressed asphalt,' but when Crochet uses this expression it is insisted that he means a pavement of rock asphalt."

Please compare the above quotation with the record thus far made in this case, and state whether the state of facts found by the court in the Buffalo case is the same as that of this case with reference to the materials known as asphalt, compressed asphalt, etc. Inasmuch as the finding of the court with reference to the Crochet patent in the Buffalo case is contrary to the opinions you have expressed during the course of this deposition, it is desirable that you should state the reasons for this difference of opinion.

A. I am glad to have an opportunity to give reasons for a difference of opinion from that of the learned court in that case. The essential reason is that *the record in the Buffalo case contains none of the exhibit publications in this case.* Notice was given by complainant's counsel in that case that one of them might be referred to by him in the course of his argument (complainant's expert witness, Mr. Foster, having made brief mention of it), but the brief of complainant's counsel contains no reference thereto, and I understand it was not referred to in the oral argument.

It was in the absence of the clear knowledge afforded by these exhibit publications as to the specific meaning of the terms
518 "compressed asphalt," "decrepitates and becomes friable," "asphalt in powder-like state," etc., employed in the Crochet

patent that the court in the Buffalo case very naturally understood the Crochet patent as he defines it in the quotation above given and elsewhere in his opinion in that case. The exhibit publications referred to are so conclusive as to the specific meaning of the terms mentioned and as to their limiting effect upon the meaning of the Crochet specification that had Judge Coxe received the benefit of the explanations said publications afford, I believe he would have obtained the same understanding of the Crochet patent that I have herein expressed.

Where Judge Coxe says, "various words and phrases are pointed out as supporting this theory" (referring to the theory of "contention of the complainant's expert * * * that the words 'asphalt pavement' must be read 'rock asphalt pavement' and the words 'pavements of bitumen' indicate another class of rock asphalt pavement") he meant "various words and phrases" of the Crochet patent, and evidently had no reference to words and phrases found in these prior publications, for the court immediately proceeds with the words:—"For instance, Crochet says," etc.

Not only do the exhibit publications in the present case supply information in support of the understanding expressed in the Buffalo case by complainant's expert, and the absence of which Judge Coxe remarked in his opinion, but the affidavits of A. L. Barber, Stevenson Towle, Clifford Richardson and Edward P. North, admitted as evidence in this case and setting forth from personal knowledge the character of French asphalt pavements and 519 other facts in harmony with said exhibit publications, serve, in my opinion, to make any other view than that expressed by the expert in the former case, and herein by me, impossible.

Adjourned to Thursday, November 3, 1898, at 10 a. m.

Chicago, November 3d, 1898.

Met pursuant to adjournment.

Parties present as before.

Q. 8. What do you find in the literature of the prior art as to the proportion of bitumen in natural rock asphalt, and how does this compare with the American mixture?

A. The percentage of bitumen in rock asphalt (known simply as "asphalt," in France), is variable. Malo, the highest authority on the subject, near the top of page 6 of the translation of "Malo Article No. 1," says:

> "Regarding bituminous limestone or *'asphalt'* properly so-called, * * * this is a rock formed of 90-94 per cent. pure carbonate of lime and of 6-10 per cent. bitumen."

The Exhibit "Chambrier Article," on page 276 says:

"Following the precedent of M. Malo, the word 'asphalt' will be used to designate bituminous limestone. * * *

"Asphalt is pure carbonate of lime, naturally impregnated with bitumen in very variable proportions; but this for road-making should be limited to between 7 and 12 per cent."

The American asphalt mixture contains about 15 per cent. of asphalt cement, of which 85 per cent. to 90 per cent. is refined lake bitumen, and 15 per cent. to 10 per cent. a heavy petroleum or "residuum" oil, serving as a flux to the bitumen.

520 In the estimated amount of bitumen in the rock asphalt there is, of course, included not only that which is present on the surfaces of the granules forming the "powder" of that substance, but also that within said granules from naturel and molecular impregnation. The comparison of American asphalt mixture with rock asphalt powder with respect to the quantity of bitumen contained by them, respectively, should, I suppose, have reference to that which is externhl to the powder granules in one case, and to the sand grains in the other. There is hence a much larger proportion of exposed bitumen in the American mixture than in the rock asphalt powder. Practically, there is in the rock asphalt powder no free mass of bitumen at all, said bitumen being an "almost atomic" "varnish," while in the American mixture the bitumen or "asphalt cement" is altogether free, forming a very considerable body wholly external to the sand grains.

Q. 9. As bearing upon the essential differences between the two materials, rock asphalt and American mixture, what do you find in the literature set up by the defendants, in addition to what you have already referred to, tending to confirm the opinions you have already expressed as to the *essentiality* of the differences between said materials?

A. The passage found at the top of page 290 of Defendants' Exhibit Chambrier Article seems to be conclusive on this point. I quote it in full, as follows:

"It has been already stated that bituminous limestone heated to between 212° and 300° Fahr. loses its consistency, and is reduced to powder. If the heating be increased the
521 powder does not melt, but the bitumen is evaporated, leaving the limestone, when at red heat, perfectly pure. If, however, on attaining a temperature of between 390° and 480°, a small portion of free bitumen be added the asphalt melts. This property leads to a *complete transformation* of the bituminous limestone; after melting it is no longer possible to recon-

stitute the asphalt and bitumen. Analysis gives bitumen and white limestone, *but not bituminous limestone or asphalt.*"

From the foregoing, it appears that in experiments upon rock asphalt and in an unsuccessful attempt to reproduce the natural product, a product resulted somewhat analogous to the American mixture. That is to say, there has resulted a mere mixture of pure limestone granules with free bitumen. It is this unexpected compound that the author calls "a complete transformation of the bituminous limestone," by which I understand him to, in effect, say that it is essentially different from the bituminous limestone or rock asphalt. If such accidental product of experiment be essentially different from rock asphalt, it follows that the American asphalt "mixture" is, for the same reason, essentially different from rock asphalt. The difference in both cases is somewhat in kind like the difference between a mere mixture and a chemical combination. Nature produced in the rock asphalt something that cannot be made artificially even from the same substances.

The passage above quoted from the Chambrier Article is continued as follows:

> "Moreover, if two pieces of asphalt rock, one containing from 5 to 6 per cent. of bitumen, the other 15 per cent. of bitumen, the latter will not melt alone, whereas it will suffice to add 7 to 8 per cent. of pure bitumen to the former to
> 522 induce fusion and make a mastic, though less rich in bitumen than the first; *but it will not remelt without a fresh addition of bitumen.* It would thus appear that pure bitumen acts as a flux."

The American asphalt mixture melts and remelts repeatedly at the same proper temperature; besides that, it never powders or "decrepitates."

The statement in the above quotation that a "mastic" produced by adding pure bitumen to rock asphalt powder and therefore (as elsewhere stated) melted in the act of manufacture, "will not re-melt without a fresh addition of bitumen," indicates that after a mastic, or so-called bitumen sidewalk pavement has been laid it does not remelt by the application of heat thereto in the process of repair, but "decrepitates," like the "compressed asphalt" of a roadway. This goes to show the substantial continuing identity between the compressed asphalt of a roadway, made of rock asphalt "unalloyed," and a mastic of bitumen sidewalk pavement made principally of rock asphalt, but alloyed with additional bitumen and containing "fine gravel."

Q. 10. You and other witnesses in this cause have referred to

the formation of a thin crust on the surface of American asphalt mixture pavements. Please state if you have made any experiments which will enable you to assert this fact with certainty, and also state what, if any, phenomena you have observed accompanying the application of the heat to the pavement by the Perkins method.

A. I have observed numerous applications of the Perkins method to the repair of American asphalt pavements, some of
523 which I directed since giving my *prima facie* deposition in this case with especial reference to the matters referred to in question.

It is a fact that a thin, continuous crust or scale is formed at the top of the pavement material where the flames impinge thereon. Beneath this scale the pavement mixture is melted, by which I mean that the "asphalt cement" is melted and the sand heated so that the mixture, as far down as the melting heat may have been carried, is in a plastic or semi-fluid condition corresponding to the condition in which said mixture is originally laid. The scale formed at the immediate surface of the pavement appears to wholly prevent the burning or impoverishment of the cement beneath it, so that the latter is, in fact, *only* melted, and is apparently as rich, bright and efficient as ever. There appears also to be an abundance of the cement and such equal distribution and fluidity of the cement throughout the mass softened beneath the scale that, presupposing any degree of impoverishment of the cement near the surface by years of exposure of the pavement to the sun and weather, the inference may fairly be drawn that equalization towards the surface may have taken place under the heat, as grease from a garment may be drawn upward into a superposed piece of cloth upon which a hot flat-iron is laid.

There is nothing produced answering in any way to what may be called "decrepitation" or "powdering." Even the thin scale formed upon the surface is not powdered, but is continuous. In some instances it is broken or formed into large pieces, and it may be very readily broken into fragments by strokes of a rake or by hand when cool.

524 In practice this scale or crust is pulled off before adding the new mixture together with some of the melted material beneath it. Evidently it might be broken up into small pieces and in that form stirred into the melted mass either previous to or at the time of the application of the new material; but it is, of course, better that it be removed, so that only fresh, lively and suitably rich material shall enter into the repair. Undoubtedly the small

amount of mixture formed into the crust or scale is impoverished by action of the flames immediately thereon, by which I mean that the bitumen and oil actually reached by the flames are probably burned out. But, by reason of its continuity and density, this scale serves to protect the mixture beneath it in a manner evidently calculated to prevent impoverishment thereof, and, on the other hand, to secure a mere melting of such subjacent material, even though the remelting be continued to a considerable depth by prolonged application of the flame to the scale.

From one to three minutes is all the time necessary to continue the application of the flame blast heat of the Perkins method to accomplish deep enough melting of the pavement for the purpose of repair. Upon a pavement said to have been laid seven or eight years I have directed the continuation of flame heat of the Perkins method for ten minutes and found no burning, but only a melting, of the asphalt mixture beneath the scale. The scale was, however, somewhat thicker than that produced in the shorter period referred to.

Adjourned to Friday, November 4, 1898, at 10 a. m.

525 Chicago, November 4, 1898.

Met pursuant to adjournment.

Parties present as before.

Q. 11. Have you examined the file wrapper and contents of the Perkins Method Patent No. 501,537, and if so, please state whether you find anything therein at variance with your opinion expressed with regard to the particular kind of heat to be used in connection with the Perkins Method?

A. I have examined the patent file referred to and I find nothing therein at variance with my heretofore expressed opinion concerning the particular kind of heat or medium or mode of heating involved in the Perkins method. The view which I have expressed is that the Perkins mode of heating is fundamentally by "transmission" from a flame borne into contact with the surface of the pavement. No other method was shown or referred to at any time in history of the application before the Patent Office.

Three claims were at first submitted to the Patent Office, the present two claims and a third, which latter differed from the present first claim in the use of the words "a strong blast of heat" where only the word "heat" is employed in the present claim 1. *There were no references cited to any of the claims*, but the examiner took the ground stated in the following words, taken from his official letter in the file:

"The 1st and 3rd claims are the same in substance, differing only in degree, and both cannot be permitted to remain in the case.

"It seems unnecessary to remark that the *process* is not modified whether the materials 'subjected to heat' or 'subjected to a strong blast of heat.'"

526 Applicant's attorney, without expressing acquiescence in the opinion expressed by the examiner in the last quoted paragraph, assented to the demand made in the first paragraph, and, retaining the more generic of the two claims, ordered the erasure of claim 3 which called for the "strong blast of heat."

Neither of these claims specifically mentioned flame as the source of heat, or contact of the flame with the pavement, giving the method of "transmission." But, as before stated, flames blown into contact with the pavement are shown in the drawings and referred to in the specification, and the understanding of claim 1 here in suit to include that idea or mode is, in my judgment, clearly not prohibited by the erasure of original claim 3. Moreover, if it were thought necessary or desirable to give claim 1 a still broader interpretation. It might, in my opinion, be read to mean "blast of heat," without prohibition from the erasure of original claim 3, which read "*strong* blast of heat." Such a reading of claim 1 would still be in keeping with the particular objection expressed by the examiner to the retention of both claims, his objection being that they differed "only in degree." There will be precisely a mere difference of degree between "blast of heat" and "*strong* blast of heat."

In other words, the examiner's objection was based solely on the question of degree, and not at all on the question of kind or mode of application, and present claim 1 can, in my judgment, be read to mean flame heat by contact or blast flame heat by contact, without inhibition from the erasure of original claim 3, even if the patentee may not actually narrow his present claim 1 to the exact terms of the narrower claim originally erased, if he chose.

527 PERKINS' APPARATUS PATENT NO. 560,599.

Q. 12. Please compare the patents, offered in evidence by the defendants as showing the prior state of the art, with the Perkins apparatus patent in suit, No. 560,599, and state whether you find therein anything tending to modify or change the opinion you have previously expressed with regard to the said patent in

suit. Please make your answer full, and give your reasons for any opinions which you may express.

I have examined the prior patents referred to in the question, and I find nothing therein which leads me to change the opinion I have previously expressed.

My direct statements concerning this patent are found on pages 30, 31, 32, 33 and to question 5, on page 34, and also in my answer Q. 7, which begins on page 36 and ends on the middle of page 42, Complainant's Printed Prima Facie Record. My cross-examination relative to the apparatus patent was, I believe, confined to X. Q. 61 and X. Q. 62, found and answered on pages 71 and 72 of Complainant's Printed Prima Facie Record.

Defendants' exhibits, bearing upon the apparatus branch of this controversy, lettered N to V, inclusive, are, I believe, introduced exclusively as showing the prior art and not as furnishing an anticipation of the patent referred to. They are the following:

N. Craig Patent.
O. Bogia Patent.
P. Waterbury Patent No. 1.
Q. Waterbury Patent No. 2.
528 R. Hayes Patent.
S. Kendrick Patent.
T. Zimmerling Patent.
U. Curl Patent.
V. Risdon Patent.

The "Perkins Senior Apparatus Patent," also offered in evidence as showing prior art, is the patent taken out on the same day with the Perkins method patent, being a patent for the identical apparatus illustrated, but not claimed, in said method patent.

Not one of the exhibit patents, N to V, inclusive, pertains to the paving art. The Craig patent is for a grass burner; the Bogia patent is for a machine for removing snow and ice from roadways; the Waterbury patent No. 1 is for a machine for removing snow and ice from roadways; the Waterbury patent No. 2 is for a machine for melting snow; the Hayes patent is for a paint breamer; the Kendrick patent is a machine for melting snow and ice; the Zimmerling patent and the Curl patent are for self-heating flatirons, and the Risdon patent is for a machine for igniting grass to head off prairie fires and called a fire guard and back firing machine.

The only patents among the exhibits pertaining to the art of asphalt pavement repair, or to any branch of the paving art, are the

Perkins patents, to wit, Perkins' senior apparatus patent and Perkins' patent No. 542,349, forming a part of "Defendants' Exhibit (L) Perkins' Apparatus File No. 1."

529 THE CRAIG PATENT.

Taking up the exhibit patents in their order, beginning with the Craig patent, the object of the Craig machine is said to be "for burning and thereby destroying green grass, noxious leaves, insects and combustible obstructions growing and lying upon the fields in, or intended for, cultivation." The apparatus consists of a plate-iron "sledge" having its sides and top continuous and its bottom slotted lengthwise, I would say, to form what the patent calls a grate, which sledge slides along the ground as the apparatus is drawn forward "by horse power." Near the front part of the top a grate is formed in said top and covered by a fire-box, in which fire-box coals are shown in the first figure of the drawing. The nature of the fire is not directly referred to in the specification. Into the top of the fire-box leads an air flue, which proceeds from a rotary fan chamber further back on the sledge. Behind the sledge is dragged a large wheel resting upon the ground, and having upon its prolonged rotary axle a pulley, over which a belt is trained to a small pulley on the fan shaft. The patent says: "The wheel, being in contact with the ground, gives motion to the fan, which drives a current of air into the fire-box, forcing the flame downward through grates to the ground, and may be passed through rows of cotton, corn, sugar-cane, etc., the rows of plants being protected from the action of the heat by the runners of the sledge A."

In keeping with the further statement of the patent that the machine "is intended to be drawn by horse power," and the
530 obvious fact that the fan operates only when the machine is in motion, it is evident that when the machine is standing still there will be no blowing of flame or heat downward from the elevated fire-box "through grates to the ground," and, therefore, that this machine, besides belonging to a remote and wholly unallied art, has no possible adaptation for use in the repair of asphalt pavements, and that it furnishes no suggestion of the apparatus described and claimed in the Perkins apparatus patent No. 560,599.

Aside from these general and ample reasons, the Craig sledge appears to be open at both ends, the front and upturned end of the

bottom being presumably grated, as I understand the horizontal portion of the bottom to be from the use of the word "grates" in the plural. For this reason the Craig apparatus fails to respond to certain of the claims of the Perkins patent, which are conditioned on the closure of the Perkins hood at one end, except as perforated for the admission of the burners or burner flames and air for their supply. Further, a grated bottom is not suited to the purpose of the Perkins patent, which shows and requires that the hood shall be bottomless. This is necessary to enable its sides to rest upon or closely proximate the pavement surface throughout their length, and also to give free access of the flames to all portions of the pavement surface. For these and other obvious reasons, I regard the Craig patent as having no relevance to the Perkins patent in suit.

531 THE BOGIA PATENT.

The Bogia Patent for a Machine to Remove Snow and Ice from Roadways corresponds, in its broad features, with the Craig device just considered. There is, however, nothing in the nature of a hood in the Bogia machine. A platform supported upon four wheels carries a fire-grate to which a fan, driven by a hand-wheel, supplies air from beneath. Over the fire-grate the end of a tube is arranged, which tube is carried forward over the front of the platform and there bent downwardly and bifurcated to furnish two downwardly directed discharge openings in front of the ground wheels, as shown in Fig. 3, this being a special adaptation for railway use. Brooms placed in front and rear of the truck wheels sweep off the tracks as the machine advances. The fire shown is of coals and the "blast" is obviously one of the products of combustion or, in common terms, "hot air." The distance between the fire and the discharge ends of the tubes precludes the emission of flames, I think, and the patent evidently contemplates nothing in the nature of a flame reaching the ground or the track, since it speaks only of "a blast of such a heat that the snow or ice which may have accumulated on the rails or tracks will be rapidly melted," and of "the snow and ice remaining on the rails being melted by the hot blast." The hot air blast is not distributed, but, on the other hand, is concentrated at points narrowly localized, and the objects of the machine can be accomplished, if at all, only by advance of the machine when "drawn over the track from which the snow and ice has to be removed." It is therefore of no

532 consequence that the "hot blast" can be kept up while the machine is at rest, either by a man turning the wheel to operate the fan, or by an engine suggested in the patent to replace the man. I think it plain that the Bogia snow and ice melting machine has no bearing whatever on the Perkins patent under review.

THE WATERBURY PATENT, NO. 1.

The Waterbury Patent No. 1 is for "Improvement in Means for Removing Snow and Ice from Streets and Drying Mud." This machine is to be drawn by four or more horses, as indicated by the driving reins which, in Fig. 1, lead from the driver's hands over the pair of horses there shown, to the "leaders" or forward team, omitted from the figure. Like the machines of Craig and Bogia, a coal fire on an elevated grate is fed with air from a fan, the air blast in this case being downward, and the fan being driven from a ground wheel, as in the Craig Grass Burner. The downward blast can therefore be kept up only while the machine is advancing. The blast, moreover, consists solely of hot air and gases, and not of a body of flame filling a confined space into which it is driven. The principle of heat transference is, therefore, that of "convextion" and not of "transmission." It is, hence, immaterial that this Waterbury patent shows a confining hood laterally restricting the area over which the heat is distributed as the machine is "drawn along the street, * * * up one side * * * and down the other, until the whole space has been worked over."

533 The Waterbury Patent, No. 1, for a Snow Melter and Mud Dryer, in my opinion, has no more pertinence to the Perkins apparatus patent in suit than either of the other prior devices for equally foreign purposes, last above considered.

THE WATERBURY PATENT, NO. 2.

The Waterbury Patent, No. 2 is for an Improvement upon the device shown and described in the Waterbury Patent No. 1. In the improved Waterbury machine "hydrocarbon oils or vapors thereof" constitute the fuel, and the burners are arranged "to drive the flame down on the snow and ice to be melted with great force." The point of contact of the flame with street surface is, however, narrowly localized and special devices are provided "to effectually prevent the flame from spreading out laterally and losing its force"

—the very contrary of the Perkins construction and of the requirements of an apparatus for Perkins' purpose. Such narrow localization of the vertically directed flame in a single line of burners across the very front of the Waterbury machine *necessitates a movement of the apparatus along the street* to give the result sought by Waterbury, which would defeat the result sought by Perkins. Moreover, it is to be remembered that the Perkins apparatus patent in suit, No. 560,599, has for its principal improvement a horizontal arrangement of the burners at one end of the hood, instead of the vertical arrangement present in the apparatus shown in his earlier method patent, which was found to act too violently in spots, because the machine is necessarily sta-
534 tionary in doing its work. Violence, on the other hand, in the Waterbury Snow Melting Machine is exactly what is there wanted. Hence, the whole force of the machine is concentrated along a narrow line across the front of the machine and special vertical tubes are provided to laterally confine the flames from the several burners until they reach the ground. Then, by a *forward movement of the machine*, the snow is melted along a strip of the street the width of the apparatus.

In the use of oil as fuel and of downwardly directed flames Waterbury in his second patent did nothing more than Perkins himself had done, and if Perkins' earlier patent was no bar to the grant of the patent in suit, the Waterbury No. 2 patent plainly cuts no figure against said patent in suit, even disregarding the fact that it is for the wholly different purpose of melting snow or evaporating water from mud upon a roadway, and also disregarding the fact that its operation calls for traveling movement.

Adjourned to Saturday, November 5, 1898, at 10 a. m.

Chicago, November 5, 1898.

Met pursuant to adjournment.

Parties present as before.

THE HAYES PATENT.

The Hayes patent for a "paint-breamer" shows a hand apparatus to be held and moved over and along a painted surface for the purpose of softening the paint, and thereby facilitating its immediate removal by means of a wide and straight-ended blade of the
535 spatula order. The "breamer" is carried in one hand and the scraper in the other.

The improvement in the breamer appears to be twofold. First,

the ordinary metal vapor pipe is curled at its discharge end, and over this is thrust a flat tapered tube, which hugs the curl of the pipe, and may therefore be adjusted to various angles with the pipe. The flame emerges from the small end of this adjustable, flattened and tapered tube. The second improvement consists in a detachable, shovel-like plate having an eye, into which the small end of the tube tapered may be inserted, said eye answering in situation to the point where a shovel handle is attached to its blade. The lateral edges on opposite sides of this plate are upturned. When attached to the tapering tube the flame from the latter spreads out *over* the plate and passes off the farther edge of the latter into contact with any painted surface against or near which said outer edge of the plate may be held by the operator. This plate, lettered D in the drawing, serves to guard the surface beneath it from injury or to protect glass adjacent to a painted surface to be breamed from harm. The plate D is, therefore, called in the patent a "protecting or defending plate D," and it seems to be regarded as useful especially in operating on the under side of horizontal woodwork.

This plate D is not a hood beneath which the flame passes, but is a defending plate or guard *over* which the flame passes to the desired point where the paint is to be burned off. The patent is, therefore, understood to have been cited exclusively for the purpose of showing the fuel pipe curled or coiled within the tapered tube where the confined flame produced at the pipe nozzle 536 comes in contact with the pipe so as to heat it, and thereby vaporize the liquid hydrocarbon on its way to the nozzle to give vapor instead of oil at the point of ignition. This is a feature present in the construction of the patent in suit, the fuel pipe being, in the Perkins device of that Patent, coiled beneath the hood containing the flames. This feature is specified in only claims 4 and 5, which contain other features novel in pavement treating apparatus, and are, therefore, not dependent upon this specific feature of arrangement of the fuel pipe as described. However, in my opinion, the combination in the Perkins apparatus of the pipe with the hood co-operating with the pavement to enclose and confine the flames is in itself a different combination from that presented in the Hayes patent, so that even in this particular I regard the Hayes patent as having no material bearing upon said claims of the Perkins apparatus patent. It has been common in apparatus for burning liquid hydrocarbon to provide various forms and arrangements of devices for vaporizing the liquid on its way to the burner or nozzle, and if, in said claims 4 and 5 of the patent in suit, the arrangement of the fuel pipe beneath the hood or flame

chamber is not to be regarded as contributing to patentable novelty, but only as a limitation upon said claims, the claims are still, in my opinion, for novel and patentable subject-matter and are unaffected by the Hayes patent and by similar provisions in vaporizing hydrocarbon burners wherever found.

The Hayes patent also appears to show a plain open nozzle (pipe-end) instead of a needle-valved or otherwise valved discharge opening, for the emission of vapor or oil. This, also, is a
537 feature in the Perkins apparatus, but not mentioned in any of the claims of the patent. The claims are, therefore, independent of this feature, and the Hayes patent cuts no figure by reason of its showing this old feature of construction.

Cross-question 62 of my prima facie deposition now appears to have had reference to this Hayes Paint Breamer patent, and I refer back to that cross-question as indicating a misapprehension on the part of defendants' counsel with respect to what he has there called a "hood," if, by that term, he had reference to the "protecting or defending plate D." Counsel seems to have understood that the flame passes beneath this plate and not over it. If this was his view, he will find reason for correcting it by reference to Fig. 3 in connection with Fig. 1, where the eye *d'* for the reception of the small end of the burner tube B is in full view. Fig. 3 is described in the specification as being a "full view of the side protector detached," not of the protector *inverted*. What is said in the specification about its utility is also in keeping with my understanding and directly at variance with that of counsel.

If, on the other hand, counsel had reference to the flattened tube B as a "hood," it is plain said tube is not a hood in any sense of the Perkins patent, but is rather the real burner nozzle proper, since the flames are utilized outside of it exclusively, and only where said nozzle directs them.

On the whole, the Hayes patent, in my judgment, has no bearing whatever upon claims 1, 2 and 3 of the Perkins apparatus patent, and no material bearing upon claims 4 and 5, in view
538 of the remoteness of the art to which it belongs, of the structural and operative dissimilarities, and of the total inadaptation of the Hayes device for the purposes of the Perkins apparatus, wholly irrespective of the differences in dimensions and mode of manipulation.

THE KENDRICK PATENT.

The Kendrick patent for a Machine for Melting Snow and Ice is not widely different from other machines for this purpose shown and described in other of defendants' exhibit patents. From a platform supported by four wheels depend side and end boards making a complete enclosure extending down nearly to the tracks or roadway. In the front end of this enclosure are arranged separately enclosed transverse oil burners, the special narrow enclosure for these burners being called a "combustion chamber." This snow melting burner arrangement precedes the front wheels, and over the tracks between the front and rear wheels are placed perforated "rose-heads," through which steam is discharged upon the rails. Steam is mixed with the vapor of oil to give more intense heat to the flames which "fill the combustion chamber," but not the main enclosure behind it. As the machine proceeds over the track or roadway it is supposed to melt the snow or ice thereon in a path as wide as the apparatus.

The Kendrick apparatus has plainly no adaptation for the purposes of the Perkins machine, and it does not present the combination of any of the claims of the Perkins patent.

THE ZIMMERLING PATENT.

539

The Zimmerling patent shows a "Combined Smoothing, Fluting and Polishing Iron." The supposedly pertinent matters are the employment of hydrocarbon liquid for fuel, and the arrangement of a portion of the fuel pipe in the path of the flame within the hollow flat-iron to vaporize the liquid fuel on its way to the point of ignition. The essential feature of a flat-iron is its bottom, and for this reason alone it presents no correspondence with the hood of the Perkins patent in suit, which is provided with no bottom, and, therefore, allows direct contact to the flames with the pavement.

THE CURL PATENT.

The Curl patent for a "Self-Heating Flat Iron" corresponds essentially with the Zimmerling with reference to the employment of liquid fuel supplied from a reservoir mounted on the flat-iron

and passed therefrom to the point of ignition through a pipe exposed to the flame and adapted, therefore, to emit vapor instead of liquid.

Both these flat-iron devices are, in my judgment, destitute of relevance to the Perkins patent in suit, the claims of which practically assume to be old all that is shown in these prior patents.

THE RISDON PATENT.

The "Risdon patent" (Risdon & Tolliver) is for igniting grass in a defined path transverse to the approach of a prairie fire, to
540 arrest the advance of such fire. It consists of a vehicle carrying a tank for liquid fuel, a water tank and a pump, and dragging behind it a pair of vertical, parallel plates, between which oil burners are arranged to ignite the grass as the machine advances, and outside the water is distributed from the tank through rose-heads or sprinklers to prevent ignition of the grass outside the path of the machine as the machine, in its progress, leaves flames behind it. The vertical plates serve as "shields" to confine the flames and grass ignition to the proper width or strip as the machine advances, and the wetting of the outside grass prevents it taking fire in the brief period that the grass may continue to burn behind the moving machine.

The burners B B employed are slotted to give flame jets in all directions, that is, sidewise, upwardly and downwardly, as I understand them, having the appearance of the slotted burners carried by lamplighters. There is clearly no intention to give rearwardly directed flames exclusively, if at all, and if there were, there is nothing in the nature of a hood to confine such flames. There is no top plate covering the space between the "shields" or vertical plates between which the burners are arranged. There is also no contrivance or arrangement for vaporizing the oil.

This Risdon & Tolliver device is altogether unsuited for the Perkins purpose, and does not present the combination of any of the claims of the Perkins patent. Hence, in my judgment, it has no bearing on the Perkins apparatus patent here in suit.

There remains only the prior Perkins patents to be considered. These were devised from time to time for the practice of the Perkins "Method" invention, and developed defects which the
541 device of the Perkins patent in suit remedied. Said patent in suit refers to two prior patents by the same inventor and points out their faults. It shows differences in construction, aim-

ing to remedy these faults, and its claims are directed to these improvements. I see no reason in said prior Perkins patents, either considered by themselves or in connection with the other patents offered by defendants, and relating to other arts, why the claims of the patent in suit were not properly allowed and are not tenable. The combinations expressed in said patent in suit are nowhere shown and described in prior patents, either to Perkins or to the other patentees referred to.

I find nothing in the prior art tending to modify or change the opinions I have previously expressed with regard to said patents in suit.

Adjourned to Wednesday, November 16, 1898, at 10 a. m.

Chicago, November 16, 1898.

Met pursuant to adjournment.

Present: Mr. W. R. Omohundro, solicitor for complainant; Mr. George P. Fisher, solicitor for defendants.

Solicitor for defendants asks complainant's solicitor whether the direct examination of the witness Dayton is closed; to which complainant's solicitor replies that it is.

Defendants' solicitor desires to place upon the record the following statement: In view of the decision by Judge Coxe (87 Fed. Rep., page 337) entitled Untied States Repair and Guaranty Company et al. v. Standard Paving Company, directed to the 542 Perkins Process patent, No. 501,537, here involved, and finding it to be invalid on the basis of the defense by prior French patent of Crochet interposed in this cause, the attorney for defendant is advised by his client to abstain from any superfluous action tending merely to multiply expense without advantage. Cross-examination of the witness Dayton is accordingly waived.

MELVILLE E. DAYTON.

Adjourned until further notice.

State of Illinois, } ss.
County of Cook. }

I, C. L. Wood, a Notary Public in and for the county in the state aforesaid, do hereby certify over my hand and official seal that upon the 27th, 29th and 31st days of October, 1898, and upon the 1st, 2nd, 3rd, 4th, 5th and 16th days of November, 1898, in the case of United States Repair and Guaranty Company vs. Assyrian Asphalt Company et al., now pending in the United States Circuit

Court for the Northern District of Illinois, at the office of Raymond & Omohundro, in the City of Chicago, I duly swore and took the deposition of Melville E. Dayton, of Chicago, Illinois; that Mr. W. R. Omohundro conducted the examination for the complainant, Mr. James H. Peirce and Mr. George P. Fisher conducted the examination for the defendants, and made objections and stipulations as above written; that said deposition was taken directly upon a typewriter by consent of counsel, and was duly examined and signed by said witness.

543 Witness my hand and official seal this 16th day of November, A. D. 1898.

C. L. WOOD,

(Seal.) Notary Public in and for the County in the State aforesaid.

My fees for taking the foregoing deposition and certifying to the same are $65.20, all of which were paid by the complainant.

C. L. WOOD.

IN THE UNITED STATES CIRCUIT COURT.

Northern District of Illinois.

U. S. Repair & Guaranty Company vs. Assyrian Asphalt Company et al. } In Chancery. No. 24,534.

COMPLAINANT'S REBUTTAL CONTINUED.

Testimony taken and evidence adduced in behalf of complainant pursuant to agreement of counsel, formal notice being waived, and the stipulation subsisting between the parties, before C. L. Wood, a notary public in and for the County of Cook in the State of Illinois, at the offices of Messrs. Raymond & Omohundro, room 1515 Monadnock Block, Chicago, Illinois, commencing at 11 o'clock a. m. on Wednesday, December 14, 1898.

Present:

W. R. Omohundro, of Raymond & Omohundro, solicitors for complainant; and

Mr. J. H. Peirce, of Peirce & Fisher, solicitors for defendant.

544 VOLNEY W. FOSTER, a witness produced on behalf of complainant, testified in answer to interrogatories propounded to him by W. R. Omohundro, Esq., as follows:

Q. 1. Are you the same Volney W. Foster whose testimony given in the suit of the U. S. Repair & Guaranty Company v. The Standard Company has been stipulated into this case?

A. I am.

Q. 2. Please state how long you have been connected with the asphalt paving business and the general extent of your knowledge of that business?

A. I have been engaged in this business since 1889. My relation to all parts of it, including construction, has been very intimate. I have considered carefully all the methods in vogue by my company, and other companies, with a view to improve the manner of mixing, laying and repairing asphalt pavements.

Q. 3. Since you gave your former deposition there has been introduced into this case by the defendants the French Letters Patent to Paul Crochet for a method of repairing asphalt pavement and also a number of articles by Malo and other foreign engineers bearing on the subject of repairing asphalt pavements. Please state when you first had knowledge of the patent and publications I have referred to.

A. I knew of the Crochet patent only after it was introduced in the Buffalo case and of the Malo statements and other articles after they were introduced into this case.

Q. 4. Do you personally know anything about the practice
545 of the methods of the Crochet patent, or of the methods disclosed in the articles referred to in the repair of asphalt pavements either abroad or in this country?

A. I do not know of such method ever having been practiced either here or elsewhere.

Q. 5. To what kind of pavements do you understand these methods disclosed in the Crochet patent and in these articles are directed?

A. I suppose it would be to rock asphalt pavements, and simply for destroying and removing portions of the pavements for the purpose of repair by the addition of new material.

Q. 6. Do you understand that that same way of repairing the American asphalt mixture pavements is what is contemplated in the Perkins Method patent in suit?

A. No; as the intention of the Perkins invention is by the ap-

plication of heat to soften a sufficient depth of the old pavement to make a perfect bond between the new and the old material, wasting the least possible amount of the old pavement.

Q. 7. Please state whether the methods disclosed by the Crochet patent and other articles are, in your opinion, adapted for the repairing of the American asphalt mixture, assuming that they are practicable for the repairing of natural rock asphalt pavement, and whether the effects of the heat upon the American asphalt mixture in a laid pavement would be the same as the effect of heat upon a natural rock asphalt pavement. Please make your answer full and give your reasons for any opinions you may express.

546 A. Rock asphalt is a natural mixture of carbonate of lime and bitumen, which rock is reduced by heating and grinding to a powder, the particles of which, under pressure, again affiliate and become a mass. The application of heat, as described in the Crochet patent, to a compressed asphalt pavement would destroy the slight adhesive bond between the particles and volatilize the oils, and so destroy its value for a pavement, so that the service of that device would be only mechanical and take the place of an axe or pick in removing parts of the pavement. American asphalt pavements are constructed of sand and bitumen with a small percentage of carbonate of lime. The action of the slow heat described in the Crochet patent, if applied to American asphalt pavements, would also destroy and make worthless that portion of the pavement which it might reduce to a condition of decrepitude. The purpose of the Perkins patent is to create a bond between the new and the old material and minimize the amount of waste. There is a great difference in the distribution of bitumen in the two kinds of asphalt. In the rock asphalt it is uniform and slight, amounting to about seven to nine per cent of the mass, and under heat the volatilization of the oils is general and uniform, creating the conditions called decrepitation. In the American asphalt mixture pavement the bitumen is free, surroundnig the separated particles of sand, but all of the bitumen is subject and responsive to the general influence of heat applied to the surface; in fact, the bitumen forms a continuous mass throughout the body of the mixture as would a quantity of water covering a mass of gravel. Obviously,

547 the application of heat described in the Crochet patent to rock asphalt pavements is for the purpose of digging out and removing a part of the pavement, while the Perkins patent is effective in creating a bond between new and old material, and so saving more than a million dollars a year in the cost of repairs on present yardage of asphalt pavements in the United States. The

Perkins heater directs a powerful blast of heat to the part of the pavement to be repaired. Such impact drawing to the surface of the mass an excess of bitumen, which to a depth of about one-fourth of an inch becomes carbonized, and this carbonized crust becoming a buffer to the balance of the mass, as through it (the crust) the melting, but not the burning, rays of the heat penetrate. Except that the heat of the Perkins heater be too long applied when the coherence of the crust is partially destroyed, and the burning rays of the heat reach deeper into the mass. The greatest care is necessary to obtain the most economical results in saving the old material in place. As with care a perfect bond or weld of the new material to the old can be made with a loss of the thickness of one-fourth inch crust only, the best practice being to remove this crust before adding new material, although the repair can be made by breaking up the crust after melting and mixing with the mass in place. This latter method is pursued where the depression to be repaired is deep.

Adjourned to Thursday, December 29, 1898, at 10 a. m.

548 Chicago, Ill., December 29, 1898.

Met pursuant to adjournment.

Parties present as before.

Q. 8. What methods of repairing American asphalt mixture pavements were used prior to the invention and introduction of the Perkins method of repair?

A. The method used then was to cut out the asphalt in, and adjacent to, the place to be repaired, and remove the whole of the old material down to the concrete, then fill up such hole with new material. This cutting out and removal of the old material was generally done with axes or pick-axes and shovels, and it was generally necessary to coat the bottom and sides of the hole with tar or asphalt cement, in order to make the patch stick to the old pavement.

Q. 9. What, if anything, was usually done with the old material cut out in making repairs to the American asphalt mixture pavements in the manner above stated?

A. This material was always thrown away as waste material. Some efforts were made by different pavement layers in different parts of the United States to render this old material usable by treating it with heat and the addition of bitumen, but such efforts utterly failed in their intended purpose, and to this day the old material dug up in making repairs by the old method is thrown away as useless.

Q. 10. What, if any, steps did you or your company or others, within your knowledge, take to obtain or discover a better method of repair, prior to the invention and introduction of the Perkins method?

549 A. As I have before stated, the Western Paving and Supply Company, of which I was president, and Mr. Perkins, vice president and general manager, commenced the laying of American asphalt mixture pavements in 1889. Very shortly after I begun to find fault with the crude and primitive method that was employed in making repairs to asphalt pavements. While most of the processes followed in making and laying asphalt pavements, such as the refining and mixing of the materials, had much of science in them, there seemed to be none at all in the work of repairing the asphalt pavements after they were laid. So far as I could learn at the time, all pavement layers made repairs, as I before stated, by cutting or chopping out the asphalt at the place to be repaired down to the foundation, and removing and throwing away the whole of the old material. The hole thus formed was then filled with new material, rolled and tamped in the usual way. This method was very expensive, because of the value of the material thus sacrificed and the new material employed to take its place, as well as the labor involved in making the repair, beside which the success of the repair was always a matter of great uncertainty, and by reason of the lack of a proper bond or union between the old pavement and the new the patch frequently became displaced, rendering a new patch necessary.

I made diligent inquiry of all of those whom I met who were engaged in this business, and I may say they were the principal pavement layers of the United States, in regard to a better method of repair, but could not find any information nor get any suggestion on the subject. The universal opinion among those hav-

550 ing knowledge of the business was that the old method of repair was the only way to make such repairs.

I then, through Mr. W. C. Murdock, manager of the Trinidad Asphalt Paving Company, of New York, made inquiry in the east at New York, Washington, Buffalo and other cities, in regard to this matter, and, at my request, Mr. Murdock called upon Mr. E. J. DeSmedt, of Washington, D. C., who was then regarded as the best authority on asphalt pavements in the United States, as he had been a pioneer in their introduction and as the mixture used then and now are largely those that he prescribed. Mr. DeSmedt informed Mr. Murdock that there was no other way

of making repairs to asphalt pavements than to cut out the old material and replace it with new.

I then went to the yards of some of the paving companies to learn what method they were pursuing, if any, to utilize or economize the old material. I found that the Warren-Scharf Asphalt Paving Company of New York were removing that portion of the pavement to be repaired from the street by cutting out in the usual way, taking it to their yards, breaking it with hammers into small pieces, putting it into open pans with a fire under them, and so attempting to reduce it to a plastic and usable condition.

In order to avoid the immediate burning and destruction of the material, they were adding water, and later, when they had volatilized the oils from the mass, and had, in my judgment, destroyed the value of the mixture for paving purposes, excepting the sand of the mixture, they added more bitumen to restore the
551 mixture, in order that it might be usable again in laying new pavements when mixed with the usual materials, or it might be carted back to the place from which it had been removed and relaid in the usual way. This method appeared to be of no value, and that there was a greater actual loss to them in the transaction than if they had thrown the old material away in the first instance.

I next visited the yards of the Barber Asphalt Paving Company, and found that they had a number of upright cylinders near their plant, which cylinders were divided into a fire-box and a melting pan. They had men stirring with wooden ladles the old material they were trying to melt in this manner. This method did not impress me as being in any way economical, because the old material had to be cut out and removed in the old way, transported to the yards, treated and enriched with additional bitumen, before it was usable in any way. This method did not economize in any way the old method of repairing, and, in my judgment, there was not even economy in the saving of old material.

The use of heat for melting old material—that is, old asphalt paving mixture after it had been laid as a pavement—was thoroughly discouraged by the general verdict among those familiar with the work that it could not be applied without burning and desicating the mass and removing and eliminating the valuable properties of the bitumen. Mr. Perkins and I had many consultations on the subject, and notwithstanding the general verdict of the asphalt paving men, Mr. Perkins still believed that he could devise a better method of repairing asphalt pavements
552 than the old method of cutting out and removing the old material. Being myself convinced that some better method

ought to be provided, I instructed Mr. Perkins to follow up his ideas, and he instituted a series of experiments in the application of heat directly upon the pavement in the place to be repaired, and after the first few trials we were both satisfied that he had discovered the right way of repairing these pavements, and I insisted that we should obtain patents upon the invention at once. There were members of my company who did not agree with me, either as to the satisfactory results of the experiments or the desirability or necessity for taking out patents upon the invention, as they had become discouraged by the general statement and belief that the application of heat would make useless the old material left in place.

We went on, however, and did get the patents, and Mr. Perkins improved the heater for carrying out his method, increasing the intensity of the heat applied, and the mode of applying the same, and made the invention an entire success.

The phenomena of the application of heat to an old asphalt mixture pavement by the Perkins heater are: First, the instantaneous application of the intense heat of a flame on the surface of the pavement causes radiation and capillary attraction, bringing an excess of bitumen to the surface of the pavement, which carbonizes and forms a thin crust of the surface material of a thickness of not more than one-quarter of an inch when the work is properly done. This crust is formed almost instantly, or, at any rate, is the first result of the application of the blast of heat to the surface of the pavement. Thereafter, if the heat is
553 not too long applied, the melting and not the burning rays of the heat are communicated to that part of the pavement material below the crust, the crust on the one side and the concrete base on the other side making the sides of a comparative vacuum chamber in which material can be melted without volatilization. We found it necessary to apply an intense heat, and to work rapidly and intelligently in the use of the heater. In my judgment, the formation of this crust which produces what I have called a vacuum chamber is the real secret of the success of the Perkins method of repair, and explains the failure of the prior attempts, to which I have before referred, to reduce the old mixture to its original condition by the application of heat thereto, because in all such prior attempts the heat had been applied in open chambers or pans where volatilization was unrestrained.

The difference between the effectiveness of the use of the Perkins heater, or, for that matter, any other heater, upon the American asphalt mixture pavements is, in my judgment, to be ac-

counted for, in part at least, by the fact that in the American pavements the bitumen is so distributed in the mass as to be continuous, and its capillaries are large, open and responsive to heat and expansion, thus making it possible to form the crust which I have before referred to; whereas in the rock asphalt pavements, where each particular small particle of lime is coated only with the thinnest possible varnish of bitumen, the capillary action is obstructed, and burning and volatilization would take place instead of melting, and no such crust as I have referred to can, therefore, be formed upon natural rock asphalt by the appli-
554 cation of heat in any way. This would be particularly true of the rock asphalt which it was sought to reduce to a paving material by heat, it having been once before reduced to a powder by the application of heat and grinding, and, in the second instance, after having been placed in a pavement and thoroughly compressed, the capillaries would be more obscure, irregular and unresponsive to the application of heat. Therefore a heater, whether it be of the Perkins type or of the basket type of the Crochet patent, used as a heater on rock asphalt, would be of no value as a repair device for such asphalt pavements, excepting that it might be used to destroy the pavement so it could be easily raked up and thrown away.

After we had proved the efficacy of the Perkins method of repair of asphalt mixture pavements we sought to introduce it generally into the business among pavement layers all over the United States, and we found the greatest opposition to the idea of melting an asphalt pavement in place and making the repair without removing any more of the old material than substantially the one-quarter to one-half inch thickness of the crust formed on the surface. The success of the Perkins invention had violated the positively asserted theory of everybody eminent in the business. As I now know, a number of asphalt pavers did remove, surreptitiously, parts from pavements upon which we had made repairs to discover whether we had made a perfect bond between the old and new material, and nothing had transpired in this business to cause such general interest and surprise as the effective-
ness of the heater. It was only after repeated assertions and
555 repeated proofs of our statement that it did not burn and destroy the material under the crust, and that a perfect bond could be made, that we succeeded in doing any business with other asphalt mixture pavement layers.

There is another advantage in using the Perkins surface heater, viz.: in practicing the old method of cutting out and removing

the old pavement at the place requiring repair, the whole was filled to the concrete base, to the two and a half inches, with new material. It was impossible for the operator to estimate the quantity of new mixture to place in such hole in order that the repaired place should be even with the surface of the adjacent whole pavement after the new patch had received its ultimate wheel compression. It would be either above or below the old pavement. By the use of the Perkins surface heater, the thickness of the new material necessary to add to make the repair is so small that the roller compression is sufficient to bring the mass to its final bearing.

Cross-examination waived.

VOLNEY W. FOSTER.

Adjourned to Saturday, December 31, at 10:30 a. m.

Chicago, Ill., December 31, 1898.

Met pursuant to adjournment.

Present: Solicitors for the parties.

By agreement of the solicitors further proceedings in this cause were postponed pending the preparation of a stipulation proposed for avoiding the expense and delay of taking certain depositions.

Adjourned to January 27, 1899.

556 Chicago, Ill., January 27th, 1899.

Met pursuant to adjournment.

Present:

Mr. W. R. Omohundro, solicitor for complainant, and
Mr. J. H. Peirce, solicitor for defendants.

And thereupon the solicitors for the parties entered into the following stipulation:

IN THE UNITED STATES CIRCUIT COURT.

Northern District of Illinois.

U. S. Repair & Guaranty Company vs. Assyrian Asphalt Company. } No. 24,534. In Chancery.

STIPULATION.

It is hereby stipulated and agreed by and between the solicitors for the respective parties to the above entitled cause:

(1) That the case referred to in this record as the "Buffalo case" and the "New York case" is the suit of the U. S. Repair & Guaranty Company and the Barber Asphalt Paving Company vs. The Standard Paving Company, brought in the Northern District of New York, and in which suit the opinion of the court is reported at 87 Fed. Rep., p. 339.

(2) The said suit was brought on or about the third day of August, 1896.

(3) That said suit was brought upon letters patent to Amos H. Perkins for an Improvement in Method of Repairing Asphalt Pavements, No. 501,537, dated July 18, 1893.

557 (4) That the answers set up the following defenses: United States Letters Patent to:

M. C. Bogia, December 23, 1873, No. Reissue 5,697 Machines for Removing Snow and Ice from Roadways.

John A. Craig, February 3, 1852, No. 8,701, Grass Burners.

C. G. Waterbury, December 23, 1873, No. 145,822, Machines for Removing Snow and Ice from Roadways.

John Mullaly, September 15, 1874, No. 154,992, Machines for Removing Snow from Roadways.

Isaac Kendrick, November 21, 1876, No. 184,628, Machines for Melting Snow and Ice.

C. G. Waterbury, deceased, C. R. Waterbury, executrix, October 13, 1885, No. 328,367, Snow Melting and Ground Heating Machine.

Patrick Griffin, June 10, 1890, No. 430,013, Paving Streets.

R. A. Healy and E. D. Cundell, October 10, 1893, No. 506,497, Method of Cleaning Streets or Railroad Tracks from Snow.

English Patents:

Adolphe Augustin Girouard, May 23, 1853, No. 1,265.
Joseph Briggs, March 30, 1861, No. 796.
George Clark, December 31, 1873, No. 4,282.

French Patent:

A. M. Crochet, June 11, 1880, No. 137,208.

and also prior public use at the following places and by the following named persons and corporations:

558 At the City of Buffalo, N. Y., by D. W. Hodge, of Buffalo, N. Y., and by F. J. Hodge, of Ordway, Colorado.

At the City of Washington, D. C., by the Asphalt Paving Company, of Washington, D. C.

(5) That of these defenses set up in said answer, testimony was taken concerning only the following:

French Patent to A. M. Crochet, June 11, 1880, No. 137,208.

English Patents to Adolphe Augustin Girouard, May 23, 1853, No. 1,265; Joseph Briggs, March 30, 1861, No. 796; and George Clark, December 31, 1873, No. 4,282.

(6) That the complainant in this suit, the owner of the legal title both of the patent sued upon in said suit against The Standard Paving Company and of the additional patents sued upon in this suit, was, with one of its licenses, the Barber Asphalt Paving Company, the complainant in said suit in the Northern District of New York; and

(7) If Volney W. Foster, a witness in this case were recalled, he would testify as follows, and the same shall be taken as evidence for the complainant in this cause, to wit:

That suit was brought against the Standard Paving Company at Buffalo because my company was urged to such action by our licensees, who claimed that the use of the coke basket by the defendant in that case was an infringement on our Perkins Method Patent. Personally, I never thought so, and our Chicago attorneys fully agreed with me, in fact, gave me a written opinion to this effect. The reason for my opinion in this matter was

559 that the application of heat by a coke basket resulted in volatilization and desiccation, and would not do any of the things on an asphalt mixture pavement that heat applied in a blast, as by a Perkins heater, will do, and must do, to make a proper, satisfactory and commercial repair to such pavements. These things I have before pointed out. I went to New York in consultation with some of our eastern licensees, and they employed an attorney who had previously been consulted by the

licensees, and who gave an opinion agreeing with the contention of the licensees, that the use of a coke basket was an infringement of the Perkins Method Patent. With this opinion, and at the urgent solicitation of the licensees, suit was brought, with the result as shown in the decision of that case.

(8) That the witnesses in the "Buffalo case" aforesaid were:

For complainants:

F. V. Greene, New York, N. Y.
C. S. Kent, Buffalo, N. Y.
C. E. Foster, Washington, D. C.
P. W. Henry, New York, N. Y.
H. J. Warren, Buffalo, N. Y.
V. W. Foster (2), Chicago, Ill.
Wm. H. Lober, Philadelphia, Pa.
J. H. Cranford, Washington, D. C.
H. R. Kasson, Kansas City, Mo.
C. H. Burwinkle, Philadelphia, Pa.
E. G. Schwendeman, Philadelphia, Pa.

For defendant:

Rudolph A. Witthaus, New York, N. Y.

560 That among the witnesses called and examined for complainant in the present suit as well as in said "Buffalo case," were the following, viz.: Charles Elwood Foster, of Washington, D. C.

That no part of the defendants' documentary exhibits adduced herein were in evidence in the "Buffalo case," except only the Crochet patent.

(9) That the certain affidavit of R. C. Ruthven, acknowledged November 11, 1898, be admitted in evidence on complainant's behalf, the same as if it were included by the provisions of the prior stipulation made between the solicitors and appearing of record under proceedings of October 27, 1898 (p. 120).

RAYMOND & OMOHUNDRO,
Solicitors for Complainant.
PEIRCE & FISHER,
Solicitors for Defendant.

Chicago, January 27th, 1899.

Following is a copy of the affidavit of R. C. Ruthven referred to in the foregoing stipulation:

561 IN THE UNITED STATES CIRCUIT COURT.

Northern District of Illinois.

U. S. Repair and Guaranty Company
vs.
Assyrian Asphalt Company et al.

No. 24,534.
In Chancery.

AFFIDAVIT.

State of New York, County of Erie. } ss.

R. C. Ruthven, of Buffalo, New York, being duly sworn, deposes and says, as follows, to wit:

First. That he, the said Ruthven, is an engineer by profession; that he is now assistant superintendent of the Barber Asphalt Paving Company at Buffalo, New York; that he has been engaged in the practice of engineering, especially in connection with public highways, for the past fifteen years; that he is thoroughly familiar with the methods and materials used in the laying of asphalt pavements in the United States, and has been since the year 1883.

Second. That he, the said Ruthven, is personally familiar with the processes, methods and materials used in the laying of asphalt pavements in Europe and has been so familiar for the past twelve years, and has personally visited Paris, London and Berlin.

Third. That to his, the said Ruthven's, personal knowledge, information and belief, with the exceptions hereinafter stated, the invariable material used in Europe in the laying of asphalt pave-

562 ments since 1879 for roadways or streets was natural rock asphalt in a dry powdered form, while the sidewalk material was a mixture of natural rock asphalt enriched with Trinidad bitumen and commonly called "coule" or "mastic"; that the sidewalk pavements are laid in a manner entirely different from the roadways, the latter being laid with a dry powdered natural rock asphalt in a heated state, called, in the finished state after the pavement is completed, in French, "asphalt comprime" or "compressed asphalt," while all sidewalks throughout Europe, on the other hand, are laid with "coule," or, in English, with "mastic" or with mastic which is laid in much the same manner that ordinary plaster is applied to a wall.

Fourth. That the material invariably used in the laying of sidewalks throughout Europe is composed of ordinary rock asphalt which has been reduced to a powder and enriched, usually with Trinidad bitumen, and made into cakes of various shapes, which cakes are subsequently broken up into small pieces, put into a kettle with a small quantity of pure bitumen or Trinidad asphalt and thoroughly melted, a small proportion of broken stone or gravel being added so that the whole mass becomes a thick plastic mass which is laid upon a suitable foundation and spread or floated with a wooden float or trowel to a thickness of about one-half inch.

Fifth. That he, the said Ruthven, knows of his own knowledge that the pavements laid and commonly known in the United States as asphalt pavements are composed of a mixture of sand, asphalt, petroleum residuum and limestone flour in about the proportion of seventy-five (75 per cent.) per cent. of sand, fifteen (15 per cent.) per cent, of asphaltum, containing a small
563 quantiy of residuum (asphalt cement), and about ten (10 per cent.) per cent. of limestone flour, which said materials, when mixed and heated to a temperature of about 350° Fahrenheit. form a thick, heavy mass that is spread upon a suitable foundation with shovels and rakes, and is rolled and compressed to form the roadway or street pavement.

Sixth. That he, the said Ruthven, personally knows that no asphalt mixture pavements, such as is above described, have ever been laid or used in Europe prior to the year 1894, with the exception of work done by the Barber Asphalt Paving Company on the Rue de Rivoli, near the City Hall, in Paris, in the fall of 1886 and the early part of 1887, and another piece of pavement laid by the Barber Asphalt Paving Company in the fall of 1886 and the spring of 1887 on the Landberger strasse, in the City of Berlin, Germany; that both of these pavements were composed of the materials commonly used in the laying of asphalt mixture pavements in the United States at that date, and were composed of about eighty-five (85 per cent.) of sand, fifteen (15 per cent.) per cent. Trinidad asphalt cement, which cement in turn was composed of about eighty (80 per cent.) per cent. of refined Trinidad asphalt, and the balance of petroleum residuum, the sand containing, in these instances, a sufficient percentage of limestone flour to render it unnecessary to add that element to the compound; that both of said pavements so laid in Paris and Berlin proved utter failures by reason of the climatic conditions and heavy traffic to which they were subjected, and that both of the

pavements so laid in Paris and Berlin were entirely removed at the expense of the Barber Asphalt Paving Company very shortly after they were laid.

564 Seventh. That he, the said Ruthven, was personally present during the mixing of the asphalt pavement compound and during the laying of the same in Paris and Berlin, as referred to in the sixth paragraph of this affidavit, and that he was in charge of the laying of said pavements as superintendent for the Barber Asphalt Paving Company; that he personally knows that the ingredients and proportions of ingredients of said pavements mentioned in said paragraph six are true and correct, and that the said materials were mixed and heated to a temperature of about 350° Fahrenheit, and while in such heated condition were spread upon a concrete foundation with shovels, rakes and hoes, was levelled, rolled and compressed to form the roadway or street pavement in the usual manner and with the best machinery, tools and labor commonly employed in the United States at that date in the laying of such asphalt mixture pavements.

Eighth. That the foregoing affidavit is made for the purpose of being used as testimony in the suit of the U. S. Repair and Guaranty Company vs. the Assyrian Asphalt Company et al., now pending in the Circuit Court of the United States for the Northern District of Illinois.

And further affiant saith not.

R. C. RUTHVEN.

Subscribed and sworn to before me this 11th day of November, A. D. 1898.

WM. G. WARREN,
(Seal.) Notary Public in and for the County and State aforesaid.

Solicitors for complainat here offer in evidence the original affidavit of R. C. Ruthven, referred to in the foregoing stipu-
565 lation, and the same is marked "Complainant's Exhibit Ruthven Affidavit."

And thereupon solicitors for complainant give notice upon the record that its testimony in rebuttal is closed.

State of Illinois, } ss.
County of Cook. }

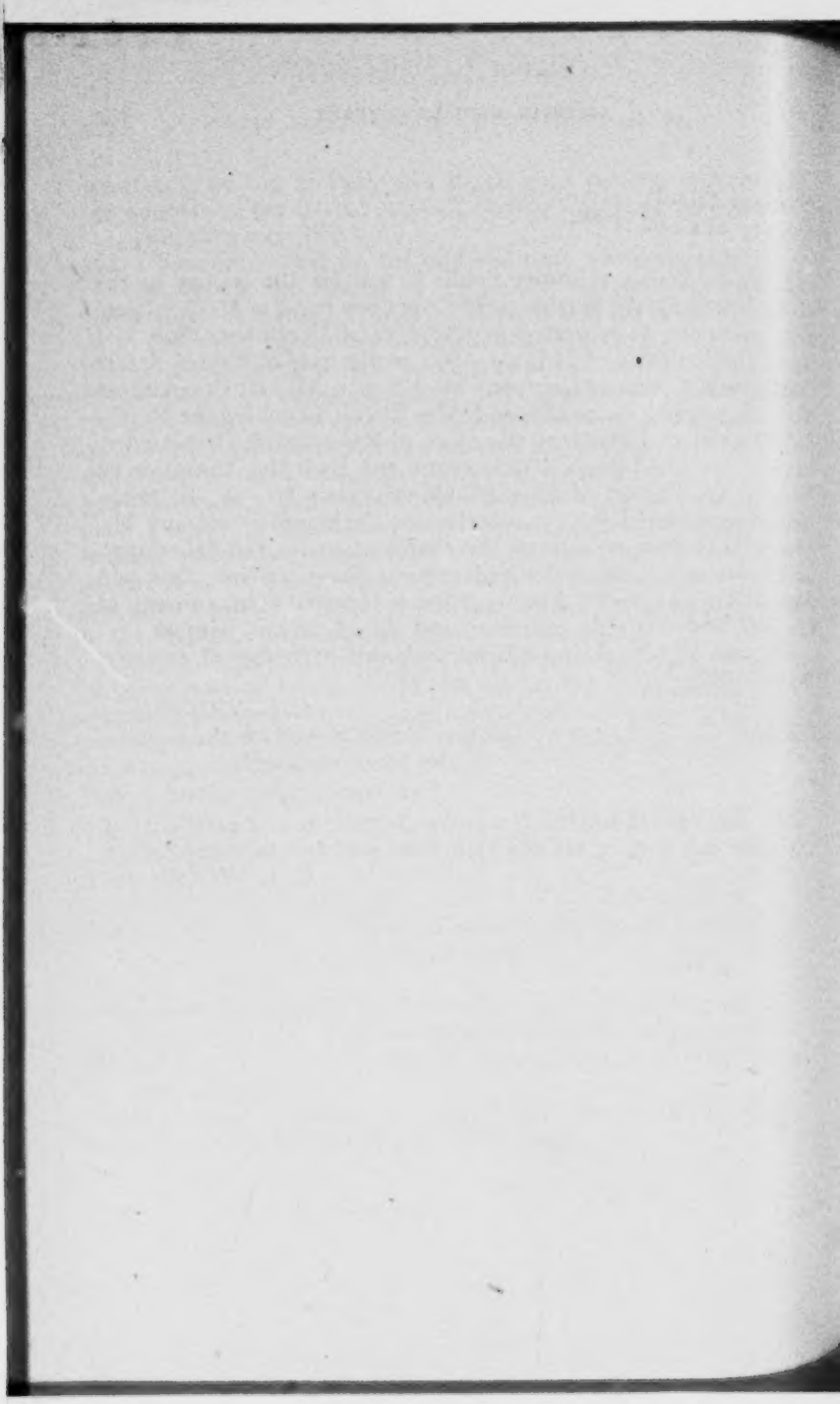
I, C. L. Wood, a notary public in and for the county in the state aforesaid, do hereby certify over my hand and official seal that upon the 14th, 29th and 31st days of December, 1898, and upon the 27th day of January, 1899, in the case of United States Repair and Guaranty Company vs. Assyrian Asphalt Company et al., now pending in the United States Circuit Court for the Northern District of Illinois, at the office of Raymond & Omohundro, in the City of Chicago, I duly swore and took the deposition of Volney W. Foster, of Chicago, Illinois; that Mr. W. R. Omohundro conducted the examination for the complainant, and Mr. James H. Peirce conducted the examination for the defendants, and made objections and stipulations as above written; that said deposition was taken directly upon a typewriter by consent of counsel, and was duly examined and signed by said witness.

Witness my hand and official seal, this 27th day of January, A. D. 1899.

C. L. WOOD,
(Seal.) Notary Public in and for the County in the State aforesaid.

My fees for taking the foregoing deposition and certifying to the same are $19.15, all of which were paid by the complainant.

C. L. WOOD.



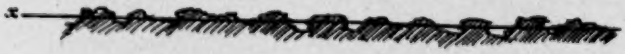
W. C. D.
Western Police

United States Circuit Court
For the Northern District
of Illinois Northern Division.

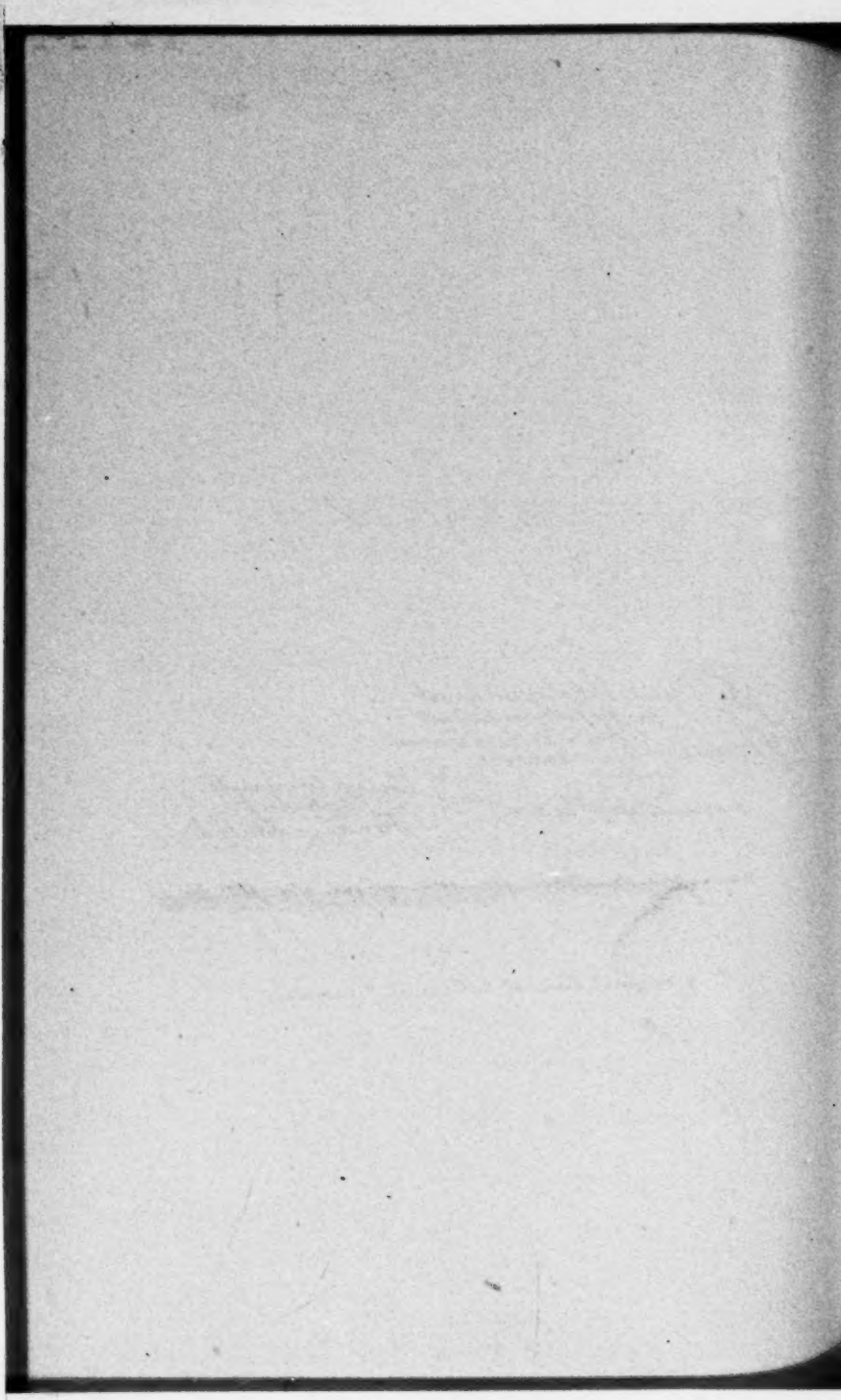
United States Fidelity & Guaranty Company
vs.
Assyrian Asphalt Co. et al

Eq. No. 24534

Complainants Exhibit
Foster Sketch.



x original line of bottom of depression.



W. C. D.
Nelson Peabody

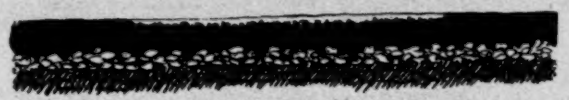
United States Circuit Court
For the Northern District
of Illinois Northern Division.
United States Reparo & Excavating Company
vs.
Assyrian Asphalt Co. et al } In Eq. No. 24534

Complainants Exhibit
Foster Sketch No. 2.

Top layer.
Binder course
Concrete.

United States Circuit Court
For the Northern District
of Illinois Northern Division
United States Reparo & Excavating Company
vs.
Assyrian Asphalt Co. et al } In Eq. No. 24534

Complainants Exhibit
Foster Sketch No 3.



Afterwards to-wit on the first day of May, 1899, in the December term of said court, 1899 in the record of proceedings thereof in said entitled cause before Hon. Christian C. Kohlsaat, District Judge appears the following entry to-wit:

Order of May 1, 1899, setting cause for hearing.

ORDER OF MAY 1, 1899.

United States Repair and Guaranty Company, vs. Assyrian Asphalt Company et al. } 4534.

It is ordered by the court that this cause be set down for hearing on pleadings and proofs on May 8.

Afterwards to-wit: on the eleventh day of May, 1899, in the December term of said court, 1898, in the record of proceedings thereof in said entitled cause before the Hon. Christian C. Kohlsaat, District Judge appears the following entry to-wit:

Hearing, May 11, 1899.

ORDER OF MAY 11, 1899.

United States Repair and Guaranty Company, vs. Assyrian Asphalt Company et al. } 24534.

Now come the parties by their solicitors, This cause comes on to be heard on pleadings and proofs filed herein.

The Court after hearing the arguments of counsel in part postpones the further consideration of this matter until tomorrow at two P. M.

Afterwards to-wit: on the twelfth day of May, 1899, in the December term of said court 1898, in the record of proceedings thereof in said entitled cause before the Hon. Christian C. Kohlsaat, District Judge, appears the following entry to-wit:

571 ORDER OF MAY 12, 1899.

United States Repair and Guaranty Company,
vs.
Assyrian Asphalt Company, et al. } 24534.

Now again come the parties by their solicitors. This cause comes on for further argument on pleadings and proofs.

The Court after hearing the arguments of counsel in full takes the matter under advisement.

Afterwards to-wit on the twenty-fourth day of June, 1899, in the December term of said court 1898, in the record of proceedings thereof in said entitled cause before the Hon. Christian C. Kohlsaat, District Judge, appears the following entry to-wit:

ORDER OF JUNE 24, 1899.

United States Repair and Guaranty Company,
vs.
Assyrian Asphalt Company and James P. Mallette. } 24534.

Now come the parties by their solicitors, and thereupon it is ordered that the motion of the complainant for rehearing be set down for argument on the 29th inst.

Afterwards to-wit: on the twenty-ninth day of June, 1899, in the December term of said court, 1898, in the record of proceedings thereof in said entitled cause before the Hon. Christian C. Kohlsaat, District Judge, appears the following entry to-wit:

572 ORDER OF JUNE 29, 1899.

United States Repair and Guaranty Company
vs.
Assyrian Asphalt Company and James P. Mallette. } 24534.

Now again come the parties by their solicitors, and now comes on to be heard the motion of the complainant for a rehearing, and the court having heard said motion and not being sufficiently advised takes time to consider.

Afterwards to-wit: on the nineteenth day of July, in the July term of said court, 1899, in the record of proceedings thereof in said entitled cause before the Hon. Christian C. Kohlsaat, District Judge, appears the following entry to-wit:

ORDER OF JULY 19, 1899.

United States Repair and Guaranty Company,
vs.
Assyrian Asphalt Company. } 24534.

The court having considered and being now fully advised in the premises, it is ordered that the motion of complainant for re-hearing of this cause be and the same hereby is overruled and denied.

Afterwards to-wit on the twenty-seventh day of July, in the July term of said court, 1899, in the record of proceedings thereof in said entitled cause before the Hon. Christian C. Kohlsaat, District Judge, appears the following entry to-wit:

INTERLOCUTORY DECREE OF JULY 27, 1899.

United States Repair and Guaranty Company,
vs.
Assyrian Asphalt Company, et al. } 24534.

This cause having come on to be heard upon full pleadings and proofs, and having been argued in open court on the 11th and 12th
573 days of May, 1899, by Mr. James H. Raymond and Mr. William R.

Omohundro, on behalf of the complainants and by Mr. James H. Pierce, on behalf of the defendants, and the court having, on the 7th day of June, 1899, handed down its decision finding said letters patent No. 560,599, granted to Amos H. Perkins, dated May 19th, 1896, and herein sued upon, to be valid and to have been infringed by the defendants, and finding said Letters Patent No. 501,537, granted to Amos H. Perkins dated July 18th, 1893, and herein sued upon, to have been in all respects anticipated by the French patent No. 137,208, issued to Paul Crochet and, therefore, invalid and void, and further finding the allegations of the bill not proven as against the defendant, James P. Mallette. and ordering the entry of a decree herein in accordance with such decision, and the complainant having on the 23rd day of June, 1899, filed its motion for a rehearing, and said motion having been heard upon full argument in open court by Mr. James H. Raymond and Mr. William R. Omohundro, for complainant, and Mr. George P. Fisher, Jr., for defendants, and the court having, on the 19th day of July, 1899, entered an order denying said motion for a rehearing, it is hereby adjudged, ordered and decreed:

I. That the evidence herein does not sustain any of the allegations of the bill as against the defendant, James P. Mallette, and the bill of complaint is accordingly hereby dismissed as against said Mallette.

II. That the complainant was the sole owner, at the date of the filing of the bill of complaint herein, of a good and sufficient title in law in and to said Letters Patent No. 501,537 and No. 560,599, herein sued upon.

III. That, prior to the filing of the bill of complaint herein, and since the issuance of said Letters Patent No. 501,537, and No. 560,599, respectively, the defendant, Assyrian Asphalt Company, has practiced the method described and claimed in said United States Letters Patent No. 501,537, without right or license from any person or persons under said letters patent, and has used the apparatus shown, described and claimed in said United States Letters Patent No. 560,599, without right or license and in infringement thereof.

IV. That said Letters Patent No. 501,537 are anticipated by the French Patent to Crochet No. 137,208, of June 11th, 1880, and are, therefore, invalid and void for want of patentable novelty, and the bill of complaint is accordingly dismissed as to said Letters Patent No. 501,537.

V. That said Letters Patent No. 560,599, are good and valid in law.

VI. That a writ of injunction issue as prayed in the bill of com-

plaint herein, perpetually enjoining the defendant, Assyrian As-
574 phalt Company, its officers, agents, representatives, workmen and employes, and each of them, from making, using or selling, or causing to be made, used or sold, any machine, device or apparatus in infringement of said United States Letters Patent No. 560,599 or of any of the claims thereof.

VII. That this cause be referred to E. B. Sherman, a Master of this court, to take an accounting herein, both as to complainant's damages and as to defendant's savings and profits derived from and arising out of the infringement by said defendant of said Letters Patent No. 560,599.

VIII. That all questions as to costs herein be reserved until the coming in of the Master's report herein.

On the same day to-wit: the twenty-seventh day of July, 1899, came the complainant in said entitled cause by its solicitors and filed in the clerk's office of said court its Petition for Appeal and Assignment of Errors, which said petition for Appeal and Assignment of Errors are in words and figures following to-wit:

PETITION FOR APPEAL AND ASSIGNMENT OF ERRORS.

IN THE CIRCUIT COURT OF THE UNITED STATES.

For the Northern District of Illinois.

United States Repair and Guaranty Company, vs. Assyrian Asphalt Company, et al.	In Chancery. No. 24534.

Prayer for Appeal and Assignment of Errors.

And now comes the complainant, United States Repair and Guaranty Company, and prays an appeal herein to the United State CircuitCourt of Appeals for the Seventh Judicial Circuit, from so much and such parts of the decree entered herein on the 27th day of July 1899 as denies complainant's prayer for an injunction against the defendant, Assyrian Asphalt Company, under United States Letters Patent No. 501,537, herein sued upon, and dismisses the bill of complaint herein as to said letters patent, and in support of said prayer for an appeal, it hereby assigns the following errors in the interlocutory decree herein now appealed from:

I. That the Court erred in refusing to grant an injunction 575 herein against the defendant Assyrian Asphalt Company, enjoining said defendant from infringing United States Letters Patent No. 501,537.

II. The Court erred in holding that said United States Letters Patent No. 510,537, granted July 18th, 1893, to Amos H. Perkins, were anticipated by the French Crochet Patent No. 137,208. of June 11th, 1880, and were, therefore, invalid and void.

III. The Court erred in dismissing the bill of complaint herein as to said United States Letters Patent No. 510,537 as against said defendant, Assyrian Asphalt Company.

RAYMOND & OMOHUNDRO,
Solicitors for Complainant.

(Endorsed) Filed July 27, 1899.

S. W. BURNHAM,
Clerk.

On the same day to-wit: the twenty-seventh day of July, in the July term of said court, 1899, in the record of proceedings thereof in said entitled cause before the Hon. Christian C. Kohlsaat, District Judge, appears the following entry to-wit:

ORDER OF JULY 27, 1899.

Allowing Petition for Appeal.

United States Repair and Guaranty Company,
vs.
Assyrian Asphalt Company, et al. } 24534.

This cause coming on to be heard on the prayer of complainant for an appeal herein from so much and such parts of the interlocutory decree of this court, entered herein on the 27th day of July, A. D. 1899, as refuses to grant an injunction herein against the defendant, Assyrian Asphalt Company, from infringing United States Letters Patent No. 501,537, as prayed in the bill of complaint herein, and dismisses said bill of complaint as to said United States Letters Patent No. 501,537, and as against said defendant, Assyrian Asphalt

Company, and the court finding said prayer for an appeal and the accompanying assignment of errors to be in due form.

It is hereby ordered that an appeal herein to the United States Circuit Court of Appeals for the Seventh Judicial Circuit be and the same is hereby allowed, as prayed, upon the filing herein by complainant, within ten days from the date thereof, of a good and sufficient appeal bond, in the penal sum of two hundred and fifty ($250.00) dollars, with surety to be approved by the court, and proceedings before the Master are hereby stayed until after the said appeal is disposed of.

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Afterwards to-wit: on the fifth day of August 1899, came The United States Repair and Guaranty Company as principal and Volney W. Foster as surety and filed in the clerk's office of said Court a certain bond on Appeal, which said Bond on Appeal is in the words and figures following to-wit:

BOND ON APPEAL.

Know all men by these presents, that we, The United States Repair and Guaranty Company as principal and Volney W. Foster as sureties are held and firmly bound unto Assyrian Asphalt Company in the full and just sum of two hundred and fifty dollars ($250.00) to be paid to the said Assyrian Asphalt Company, its certain attorneys, executors, administrators, or assigns, to which payment, well and truly to be made, we bind ourselves, our heirs, executors and administrators, jointly and severally by these presents: Sealed with our seals and dated this 27th day of July in the year of our Lord one thousand eight hundred and ninety-nine.

Whereas lately at a term of the United States Circuit Court for the Northern District of Illinois in a suit depending in said Court between The United States Repair and Guaranty Company and Assyrian Asphalt Company, et al., and the said complainant, The United Asphalt Company, et al., to-wit: on the twenty-seventh day of July, 1899 a decree was rendered against the said Assyrian Asphalt Company, et al., and the said complainant, The United States Repair and Guaranty Company having obtained an order and filed a copy thereof in the clerk's office of the said court to in part reverse the decree in the aforesaid suit, and a citation directed to the said Assyrian Asphalt Company citing and admonishing them to be and appear at a United States Circuit Court of Appeals, for the Seventh Circuit, to be holden at Chicago within 30 days from the date hereof.

Now, the condition of the above obligation is such, That if the said United States Repair and Guaranty Company and Volney W. Foster shall prosecute this appeal to effect, and answer all damages

577 and costs if they fail to make their plea good, then the above obligation to be void, else to remain in full force and virtue.

UNITED STATES REPAIR & GUARANTY CO. (Seal.)
By V. W. FOSTER, Pt. (Seal.)
VOLNEY W. FOSTER. (Seal.)

Sealed and delivered in presence of:
E. R. BLISS.

Approved by :
KOHLSAAT, J.
(O. K.) PEIRCE & FISHER,
Solrs. for Defts.

(Endorsed) Filed Aug. 5, 1899.

S. W. BURNHAM,
Clerk.

And on the 15th day of August, 1899, there was filed in the clerk's office of said court a certain stipulation, which said stipulation is in the words and figures following to-wit:

STIPULATION.

UNITED STATES CIRCUIT COURT.

Northern District of Illinois.

Northern Division.

United States Repair and Guaranty Company, vs. Assyrian Asphalt Co., and James P. Mallette. } 24534.

It is hereby stipulated and agreed that in making up the transcript of the record for the United States Circuit Court of Appeals, a printed copy of the record may be used by the clerk, and any and all errors in said printed copy are hereby expressly waived.

RAYMOND & OMOHUNDRO,
Solrs. for Appellant.
PEIRCE & FISHER,
Solrs. for Defts.

(Endorsed) Filed Aug. 15, 1899.

S. W. BURNHAM,
Clerk.

578 UNITED STATES CIRCUIT COURT.

Northern District of Illinois.

Northern Division.

United States Repair and Guaranty Co.
vs.
Assyrian Asphalt Co. et al. } 24534.

The clerk of said court will please make a transcript of the following proceedings had in the above entitled cause for use in the United States Circuit Court of Appeals for the Seventh Circuit.

Bill of Complaint.
Subpœna.
Answer.
Notice and Exception to Answer.
Order of Sept, 11, 1897.
Stipulation.
Complainant's Proofs.
Defendant's Proofs.
Order of May 1, 1899.
Oder of May 11, 1899.
Order of May 12, 1899.
Order of June 24, 1899.
Order of June 29, 1899.
Order of July 19, 1899.
Interlocutory Decree of July, 27 1899.
Petition for Appeal & Assignment of Errors.
Order of July 27, 1899, Allowing Appeal.
Bond on Appeal.
Stipulation.

Northern District of Illinois, } ss
Northern Division.

I, S. W. Burnham, Clerk of the Circuit Court of the United States for the Northern District of Illinois, do hereby certify the above and foregoing to be a true and complete transcript of all the proceedings had of record in said court in the cause entitled United States Repair and Guaranty Company vs. Assyrian Asphalt Company and James P. Mallette, as the same appears from the original records and files of said court now remaining in my custody and control.

579 In Testimony Whereof, I have hereunto set my hand and affixed the seal of said court at my office in the city of Chicago, in said District this 15th day of August, 1899.

S. W. BURNHAM,
Clerk.

(Seal.)

United States of America, ss.

The President of the United States to Assyrian Asphalt Company, Greeting:

You are hereby cited and admonished to be and appear at a United States Circuit Court of Appeals, for the Seventh Circuit, to be holden at Chicago within thirty days from the date hereof, pursuant to an appeal filed in the Clerk's office of the Circuit Court of the United States for the Northern District of Illinois, Northern Division, wherein United States Repair and Guaranty Company is appellant and you are Appellee, to show cause, if any there be, why the decree rendered as in the assignments of error mentioned, should not be corrected, and why speedy justice should not be done to the parties in that behalf.

Witness the Honorable Christian C. Kohlsaat Judge of the District Court of the United States, this 10th day of August, in the year of our Lord one thousand eight hundred and ninety-nine.

C. C. KOHLSAAT,
Judge.

Service of above citation is accepted for Assyrian Asphalt Company this 10th day of August, A. D. 1899.

JAMES H. PEIRCE,
Solr. for Appellee.

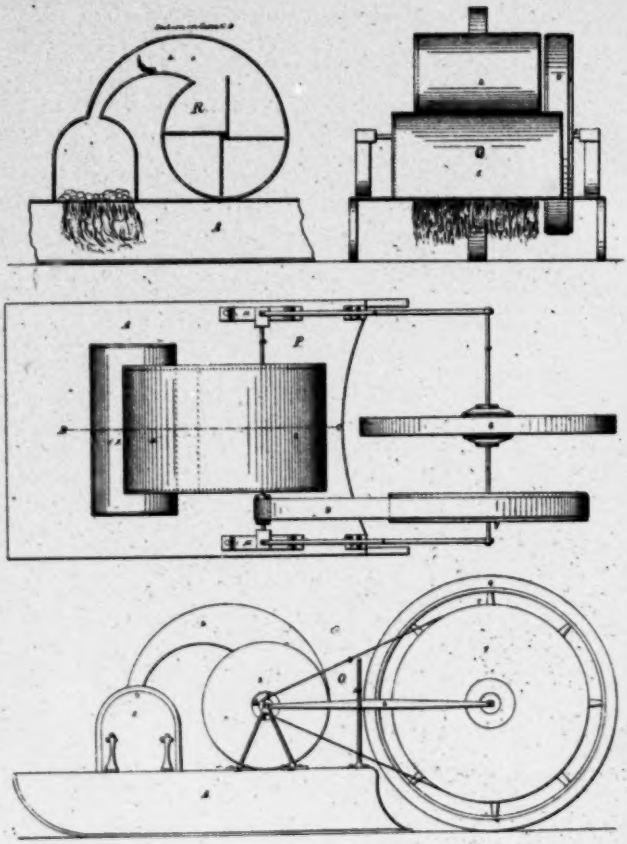
(Endorsed) Filed Aug. 10, 1899.

S. W. BURNHAM,
Clerk.

J. A. CRAIG.

GRASS BURNER.

No. 8,701. Patented Feb. 3, 1852.



UNITED STATES PATENT OFFICE.

JOHN A. CRAIG, OF COLUMBIA, ARKANSAS.

IMPROVEMENT IN GRASS-BURNERS.

Specification forming part of Letters Patent No. 8,701, dated February 3, 1852.

To all whom it may concern:

Be it known that I, JOHN A. CRAIG, of the town of Columbia, in the county of Chicot and State of Arkansas, have invented a new and useful machine for burning and thereby destroying green grass, noxious weeds, insects, and combustible obstructions growing and lying upon the fields in or intended for cultivation; and I do hereby declare that the following is a full and clear description of the construction and operation of the same, reference being made to the annexed drawing, making a part of this specification, in which—

Letter O is a perspective or side view; P a top view; Q, a front end view, and R a section or internal view.

By reference to said drawing the different members of all the parts will be understood as follows: A, rolled-iron sledge; 1, fire-box; 2, air-funnel; 3, air-barrel; 4, small drum; 5, fan for forcing the air into the fire-box; 6, wheel; 7, large or driving drums; 8, levers playing in grooved stanchions 10 to slide up and down, allowing the wheels to elevate or depress with the inequalities of the surface of the field; 9, strap connecting the driving and small drums; 10, grooved stanchions in which the levers play; 11, double stanchions for bearing of fan and small drum-axle and fulcrum of levers; 12, axle on which are fixed the small drum and fan; 13, axle on which the wheel and large drum are fixed.

This machine must be made of metal, excepting the wheel and large drum and frame in which they work, which may be made either of wood or metal. It is intended to be drawn by horse-power. The wheel, being in contact with the ground, gives motion to the fan, which drives a current of air into the fire-box, forcing the flame downward through grates to the ground, and may be passed between rows of cotton, corn, sugar-cane, &c., the rows of plants being protected from the action of the heat by the runners of the sledge A.

What I claim as my invention, and desire to secure by Letters Patent, is—

The application to the surface of the ground of flames for agricultural purposes, using for that purpose the above described machine or any other substantially the same which will by heat produce the intended effect.

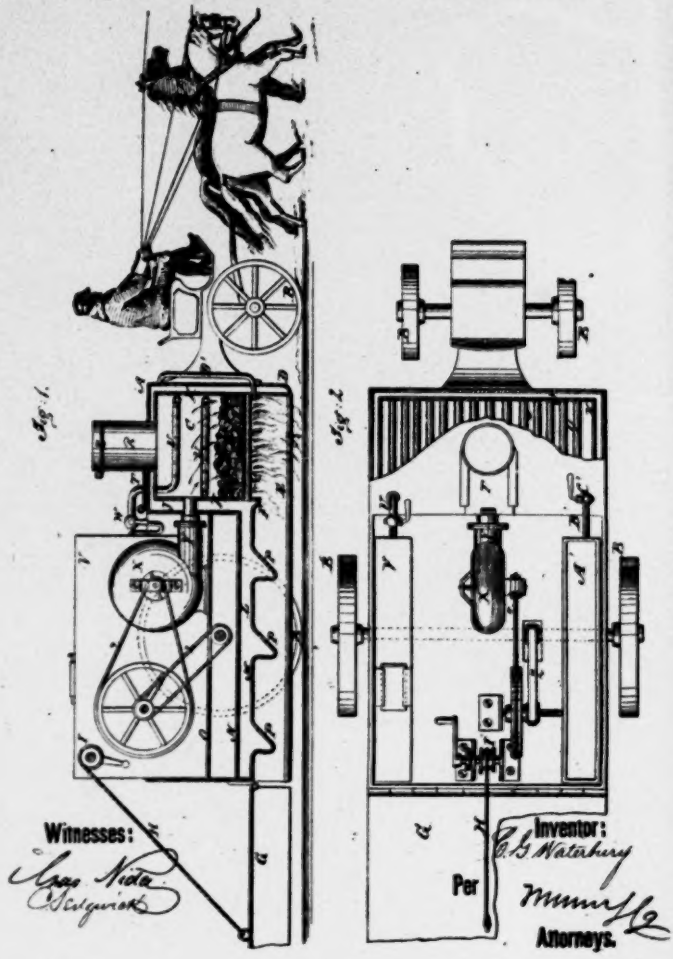
JNO. A. CRAIG.

Witnesses:
T. H. CRAWFORD,
GEO. L. DOUGLASS.

C. G. WATERBURY.

Machines for Removing Snow and Ice from Roadways.

No. 145,822. Patented Dec. 23, 1873.



UNITED STATES PATENT OFFICE.

CHARLES G. WATERBURY, OF NEW YORK, N. Y.

IMPROVEMENT IN MACHINES FOR REMOVING SNOW AND ICE FROM ROADWAYS.

Specification forming part of Letters Patent No. **145,922**, dated December 23, 1873; application filed, March 22, 1873.

To all whom it may concern:

Be it known that I, CHARLES G. WATERBURY, of the city, county, and State of New York, have invented a new and useful Improvement in Means for Removing Snow and Ice from Streets and Drying Mud, of which the following is a specification:

The invention will first be fully described, and then pointed out in the claims.

Figure 1 is a longitudinal sectional elevation of apparatus, illustrating one plan by which my invention can be carried out; and Fig. 2 is partly a plan view and partly a horizontal section.

Similar letters of reference indicate corresponding parts.

A represents an iron box, which may be of any suitable size or form, adapted to be mounted on four wheels, B, for drawing it along the street, with a furnace or fire-place, C, at the front end, inclosed on the sides and top, but open at the bottom, the front side D, and the two sides, E, at right angles thereto, extending down considerably below the rear side, which terminates at F, and said sides E extending rearward the whole length of the apparatus, to confine the heat and form a long channel for the escape of the heat, in such manner as to confine it to the work as much as possible, and, if need be, a hood, G, may be attached to the rear to prolong the channel, and the hood may be hinged to the rear end of the box, and suspended by a chain, H, and drum I, to raise and lower it, as may be required. The furnace is surrounded by an inner wall, K. Between these two walls is a water-space, J, which extends to the bottom of sides D and E, and is prolonged at L to the rear end of the box, both in the sides E and over the upper wall M of the heat-channel, under a floor, N, in the rear part of the box, over which there is another floor, O, to protect the operators and the contrivance above from the heat. The cover M of the channel has several depressions, P, to prevent the escape of the heat too rapidly, and throw it down on the snow and ice. Q represents the grate-bars, which will consist of tubes when the heat is blown down from the fire between them, and have connection with the water-space, so that the water will circulate in them and protect them from the heat. R is a charger, consisting of a large vertical tube or box rising up from the top of the furnace and communicating with it, through which to introduce the fuel. It is provided with two slide-doors, S and T, so that, by having the lower one closed and the upper one opened, it can be filled without allowing the blast to escape, and, by closing the upper one and opening the lower one, the charge can be delivered into the furnace also without allowing the blast to escape. U is a coil of pipe, having small perforations arranged around the interior walls for injecting hydrocarbon fuel from a tank, V, with which it is connected outside of the furnace, said tank being arranged in the rear portion of the box A, so that the oil will flow in, the pipe having a cock, W, to regulate the flow. X is a rotary fan arranged in the rear part of the box A, and having its discharge-pipe enter the furnace above the grate, to blow the heat down to the surface of the ground. This fan may be driven by a system of belts, Z, and pulleys connected with the hind axle of the machine, or a special steam-engine may be employed for the purpose. A′ is a water-tank for the supply of the water-space J, with which it is connected by the pipe B′, which has a regulating-cock, C′. D′ represents the pipe for conducting the steam from water-space J down to the fire below the grate, for adding its heat to that of the fire for melting the snow, &c.

In Fig. 3, the fan-blower discharges into an inclosed space, E′, below the fire, and passes up through it over a bridge-wall, F′, and then down through an open space, G′, at one side of the fire, so that ordinary grate-bars H′ may be used. This arrangement will be best for burning hard fuel only, which in the other plan probably will not burn well without hydrocarbon fuel in combination with it, and which it will probably be found best to use, either alone or in combination with the hard fuel, for it will be desirable to produce as much flame as possible, and the difference in cost will be more than compensated for by the advantages gained by the greater flame produced, and the more perfect combustion, whereby less smoke is produced. The interior heat, which can in this way be brought to direct contact with the snow and ice, will quickly melt the surface portions

and convert the water into steam, which will be superheated, and become a powerful agent, which, in combination with the heat from the furnace, will melt away the snow more quickly than any other manner by which heat can be applied, and will remove it cheaper than it can be done in any other way.

The machine will be drawn along the street next to the gutters first, to open them for the escape of the water, and next alongside of the already cleaned strip, passing up one side of the street and down the other until the whole space has been worked over.

I am aware of a patent granted to Mullay for a machine in which hot air and steam are applied in combination; but, by using steam in direct contact with fire heat, I secure the advantage of superheated steam.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. The combination, with sides D E, of cover M, having the depressions P, as and for the purpose set forth.

2. The inner and outer shells, A and K, of the furnace, forming the water-space J, extending down the sides D E, and closing the heat-channel in the rear of box Q, as and for the purpose specified.

3. The combination, with the sides D and E, forming the channel for confining the heat, of the hood G, substantially as and for the purpose specified.

C. G. WATERBURY.

Witnesses:
A. P. THAYER,
T. B. MOSHER.

M. C. BOGIA.

Machines for Removing Snow and Ice from Roadways.

No. 5,697. Reissued Dec. 23, 1873.

Fig. 1

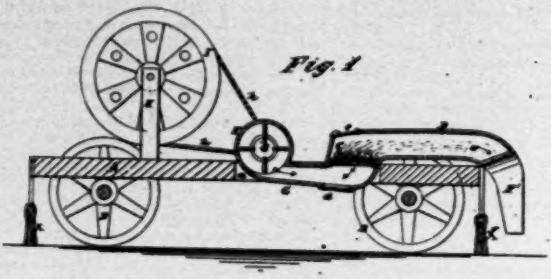


Fig. 2

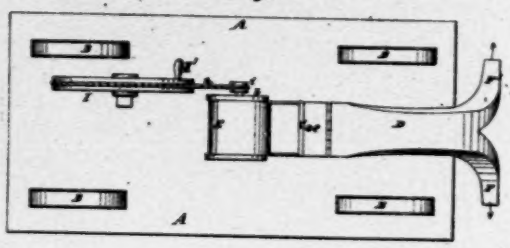
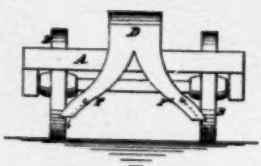


Fig. 3



Witnesses:

A. W. Almquist

C. Ridgwick

Inventor:

M. C. Bogia

Per Munn & Co

Attorneys.

UNITED STATES PATENT OFFICE

MATTHEW C. BOGIA, OF PHILADELPHIA, PENNSYLVANIA.

IMPROVEMENT IN MACHINES FOR REMOVING SNOW AND ICE FROM ROADWAYS.

Specification forming part of Letters Patent No. 37,607, dated March 17, 1863; reissued No. 5,697, dated December 23, 1873; application filed November 15, 1872.

To all whom it may concern:

Be it known that I, MATTHEW C. BOGIA, of Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented a new and Improved Apparatus for Removing Snow and Ice from Roadways, of which the following is a specification:

My invention consists of a fire-chamber arranged on a suitable truck and means so operating as to discharge onto the rails or surface of a track a blast of such a heat that the snow or ice which may have accumulated on the rails or track will be rapidly melted.

In order to enable others to make and use my invention, I will now proceed to describe its construction and operation.

On reference to the accompanying drawing, which forms a part of this specification, Figure 1 is a sectional elevation of my apparatus for removing snow and ice from roadways. Fig. 2 is a plan view, and Fig. 3 a front view.

Similar letters of reference indicate corresponding parts.

A is a truck supported on wheels B B, which may be either plain or flanged, and adapted to city railway-tracks. A portion of the truck near the center is removed, leaving the opening *a*, in the forward end of which is situated the fire-chamber C, communicating with a horizontal flue, D, which projects over the front of the truck, where it is bifurcated—if specially for railways—and formed into two pipes or tubes, F and F', which project downward, and terminate at a point above, or adjacent to, the rails of the track. At the rear of the fire-box C is a blower, E, in which revolves the spindle *b*. G is a pipe, forming a communication between the blower and the space beneath the grate *c* of the fire-chamber. The under side of the pipe G, beneath the fire-chamber, has a hinged door, *d*, and the top of the fire-chamber is furnished with a similar hinged door or lid, *e*. At the rear of the blower E, and on the truck, is an upright, H, on which turns the driving-wheel I, a belt or band from the latter passing round a pulley, *i*, on the spindle *b* of the blower, and the wheel being furnished with a suitable handle, I'.

The fuel having been introduced through the opening in the top of the fire-chamber, and properly ignited, the apparatus is ready for being drawn over the track, from which the snow and ice has to be removed.

As the truck traverses the roadway, the necessary rotary motion is imparted to the blower, so that the sparks, smoke, and other heated products of combustion will be forced through the flue D, and through the pipes F onto the rails of the track or the surface of the roadway. Under the influence of this heat, the snow and ice on and near the rails or roadway will be quickly melted, and caused to flow away.

The lower ends of the pipes F may be so formed as to project forward and act as plows to partially remove deep snow from the track, the snow and ice remaining on the rails being melted by the hot blast.

The blower may be driven from the wheels of the truck by a suitable system of gearing or pulleys and bands, or a small engine may be erected on the truck for the purpose of driving the blower.

Brushes (shown at *x*, Fig. 1) may be used to sweep from the rails any partially-melted snow or ice which may remain on the same.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. The method of clearing roadways from snow and ice by a portable furnace adapted to move along the roadway and to discharge the heat upon the snow and ice, thereby melting them and causing them to flow away as water, substantially as set forth.

2. The combination of a truck, a heat-generator, and a blower, as and for the purpose specified.

MATTHEW C. BOGIA.

Witnesses:
JOHN A. WIEDERSHEIM,
A. P. GRANT.

C. G. WATERBURY.

Machines for Melting Snow.

No. 157,559. Patented Dec. 8, 1874.

Fig. 1

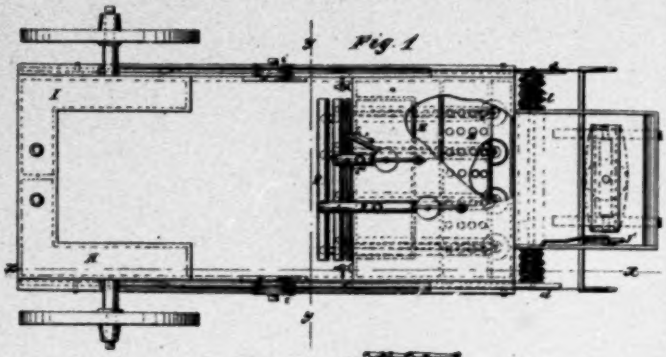


Fig. 2

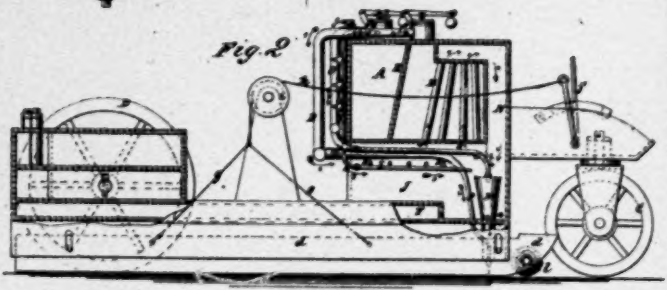


Fig. 4

Fig. 3

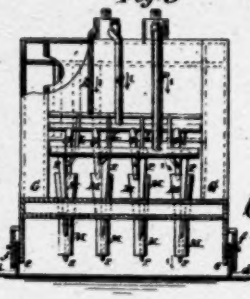
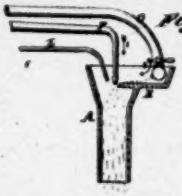


Fig. 5



WITNESSES:

A. W. Almgvist

A. F. Terry

INVENTOR:

Chas. G. Waterbury

BY

Munn & Co

ATTORNEYS.

UNITED STATES PATENT OFFICE.

CHARLES G. WATERBURY, OF NEW YORK, N. Y.

IMPROVEMENT IN MACHINES FOR MELTING SNOW.

Specification forming part of Letters Patent No. **157,559**, dated December 8, 1874; application filed August 29, 1874.

To all whom it may concern:

Be it known that I, CHARLES G. WATERBURY, of the city, county, and State of New York, have invented a new and Improved Machine for Removing Snow and Ice from Roadways, of which the following is a specification:

The essential feature of this invention consists of a series of burners for hydrocarbon oils, or vapors thereof, arranged on a portable machine, in combination with a reservoir or a retort and suitable pipe-connections for supplying the oils, or vapors thereof, to the burners, the arrangement being such that when vapors are burned they will be discharged into the burners with the requisite force by means of pressure in the retort, to drive the flame down on the snow and ice to be melted with great force. The invention also consists of the combination, with the above, of a steam boiler and pipes, for discharging steam-jets into the burners, or below them, to combine with the vapors or oils, both for impelling the flame and for increasing the heat.

The burners receive the oil or vapors at the top, and the steam is either admitted to the top or discharged at the orifice below, and forces the flame with great velocity directly on the surface of the snow or ice. The steam will be discharged into the burner at the top when heavy oils are used, in order to vaporize them, the oils being preferably discharged upon a plate or pan for spreading and holding them, to be acted on by the steam.

The burners are contrived to greatly facilitate the supply of oxygen in large measure for effecting the most perfect combustion by having a funnel-shaped top and perforated sides for the drawing in of large quantities of air by the force of the jets of vapor, which will be impelled by such pressure in the retort or boiler as to produce a velocity of twelve hundred feet or thereabout per second, which is necessary to effectually prevent the flame from spreading out laterally and losing its force, and to project it upon the snow and ice with the requisite force for melting fast enough while moving slowly along the roadway, to render the machine practically useful.

The steam-pipe will be arranged outside of the burner-tube when discharging at the bottom, in order not to interfere with the drawing in of the air through the perforations in the sides, by being forced down i a strong jet in the center and drawing the air from all directions. The burners are arranged a short distance apart, in a row extending crosswise of the machine, to clear a breadth about equal to the breadth of the track at each passage, and they will preferably be at the front of the machine.

The oil, vapor, and steam are, in this example, generated in boilers carried on the machine, both being contrived in one structure, and heated by one furnace, and by the combustion of vapor from the oil-vaporizer; and the melting-burners are fired from this furnace, and the products of combustion in it are, after passing through the boiler, carried off through the melting-burners, for utilizing the heat for melting purposes, and as the best means of disposing of them, as, after passing through the burners and coming in contact with the cold ice and snow, they are confined thereon until they escape at the rear end of the machine, and are thus cooled and condensed so as to be less injurious when finally escaping into space than if directly discharged from the furnace.

Another essential feature of the invention consists of runner-plates attached to the sides of the machine for closing in the space under the machine to the ground, for confining the heat, the said plates being capable of rising and falling, as required by irregularity of the surface, and for lifting them off the ground when the machine is to be turned around, and they are provided with means for raising and lowering them readily; and another essential feature of the invention is a horizontal revolving brush of steel wires, closing in the under space immediately in front of the burners, to prevent the escape of heat that way, and to be used for stirring and breaking up and throwing the particles of snow into the flames behind, when, by reason of being packed and saturated with water, the flames will not be sufficiently penetrating.

Figure 1 is a plan view of my improved machine, with some parts shown in horizontal section. Fig. 2 is partly a side elevation and

partly a longitudinal sectional elevation, the section being taken on the line *x x* of Fig. 1. Fig. 3 is a transverse sectional elevation taken on the line *y y* of Fig. 1. Fig. 4 is a detail section, showing the arrangement of the melting-burners when the steam is discharged at the lower end; and Fig. 5 is a detail section, showing the arrangement when the steam is discharged at the top, together with oil to be vaporized by the steam.

Similar letters of reference indicate corresponding parts.

A represents a boiler or retort for vaporizing hydrocarbon substances, and B is a steam-generator mounted on the body of a truck or car of any approved kind, having wheels C and D, and contrived to be drawn along a common roadway or on a railway. These generators are, in this example, contrived in one shell or structure, and separated by a partition, E, but they may be arranged separately, if preferred. The steam-generator is designed to be in communication with a water-chamber, F, in the platform of the truck, through the sides G of the furnace, and the water is to be supplied from a reservoir, H, by a pump or injector of any kind. This water-chamber F will be the main generator of steam, being heated below by the heat forced down under it for melting the snow. The oil-retort A will be supplied from another reservoir, I, in the same way. J is the furnace, which is to be heated by vapor-burners K, to be supplied, by small pipes L, from the retort. M represents the melting-burners, which are arranged in a row across the machine, near the front of the truck and in the back part of the furnace, being supported in the bed-plate or platform of the truck, so that the end out of which the flame issues is but a short distance above the ground, while the funnel-shaped receiving end for receiving the vapor or oil is above, in the furnace, to insure a powerful combustion, and to afford means for utilizing the heat of the furnace itself for melting purposes, the same being delivered to the burners, through the revertible flue N, from the top of the boiler. The vapor from the retort is supplied to the burners by tubes O, having a nozzle for discharging it in a forcible jet to convey it downward. P represents the steam-pipes for discharging the steam-jets at the burners. These will extend down to the mouths of the burners, as in Figs. 2, 3, and 4, when vapor is to be burned; but, when the oil is to be delivered directly to the burners, they will discharge at the top, as in Fig. 5, and in this case the oil will be discharged from a pipe, Q, upon a pan or plate, R, for retaining and spreading it, so that the jet of steam which will be discharged at the edge of the pan will be enabled to act in the best manner for thoroughly vaporizing the oil. The steam-pipes P and the vapor-pipes O pass from the boiler and the retort through the furnace, and directly over the burners K, in order to superheat the steam and vapor to prepare them for the most perfect combustion, and the pipes have suitable cocks for regulating the quantities discharged. The oil-pipes Q will not pass through the furnace, so as not to heat the oil until it comes to the burners. The pipes L, for supplying vapor to the furnace-burners, may also extend into the burners M, and discharge thereat. The furnace-burners might be attached to the vapor-pipes O, but this would necessitate a cock between them and the discharging-nozzle for each pipe to prevent the escape of vapor while heating up to begin with, and at times when the machine will be standing, and such cocks would be difficult to keep tight and to manipulate in consequence of being exposed to the fire.

By having separate pipes to each set of burners the cocks may be placed outside of the furnace, as at S T, where they will not be exposed to the fire, and can be managed better. When oil is discharged into the burners M it may be necessary to have the small pipes L, or other small pipes, projecting into the burners to be used for lighting them, the vapor being generated in said pipes, to begin with, by fire of some kind—say, a torch held under them for a short time.

The burners M have perforations *a* in the sides, above the platform, for the supply of oxygen, by means of air to be drawn in through the furnace, or perforations in its sides, by the draft produced by the discharge of the steam or vapor jets in the burner. A safety-valve, *b*, is provided to the retort, to guard against any injurious effect from excessive pressure that may accidentally occur, but it is not designed to raise the pressure of the vapor very high. The temperature of the vapor may be controlled while maintaining higher temperature on the steam-boiler by opening and closing some of the burners K. *d* represents the runners connected with the sides of the machine, for confining the heat-currents so as not to escape at the side plates *e*, and guards *f*, to be held upright, while being, at the same time, allowed to rise and fall, and they are connected, by chains or cords *g h* and a pulley, *i*, with a lever, *j*, arranged so that the driver can raise and lower them at will. *l* is the brush of steel wires arranged at the front of the machine to prevent the escape of heat thereat, and to be used for breaking up the packed snow to facilitate the melting of it. For this latter purpose it will be geared by means of belts and pulleys, or other contrivances, with one of the wheels of the truck, to be revolved thereby. This roller is, in this example, mounted in the runners, so as to be raised and lowered with them; but it may be mounted independently of them, but it will be necessary to have it rise for convenience in turning the machine around.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. The combination, in a portable machine,

of a series of hydrocarbon oil or vapor burners, M, to discharge the heat and flame upon ice and snow, a retort or reservoir, and pipes for supplying oil or vapor to the burners, substantially as described.

2. The combination, in a portable machine, of a series of hydrocarbon oil or vapor burners, to discharge the heat and flame upon ice and snow, a retort or reservoir, and pipes for supplying the oil or vapor to the burners, and a boiler and pipes for combining steam-jets with the flames for impelling them and increasing the heat, substantially as specified.

3. The combination of the hydrocarbon-burners M, furnace J, steam-boiler B, retort A, steam-pipes P, and oil or vapor pipes O or a, all in a portable machine, substantially as specified.

4. The combination of the vertically-adjustable guard-runners *d* with a portable ice and snow melting machine, substantially as specified.

5. The combination of a revolving brush, *l*, with a portable ice and snow melting machine, to rise and fall and open and close at the front end of the melting-space under the truck, substantially as specified.

6. The boiler, furnace, and its escape-passage, combined and arranged with the burners M, to cause the escaping heat to pass through and be utilized in the burners, substantially as specified.

7. The combination of the water-chamber F over the melting-space and the boiler B, substantially as specified.

8. The combination, with the burner-tubes M, of a vapor-tube to discharge into the top, and a steam-pipe to discharge in or near the bottom of the same, substantially as specified.

C. G. WATERBURY.

Witnesses:
A. P. THAYER,
ALEX. F. ROBERTS.

J. P. HAYES.

PAINT-BREAKER.

No. 169,439. Patented Nov. 2, 1875.

Fig. 1.

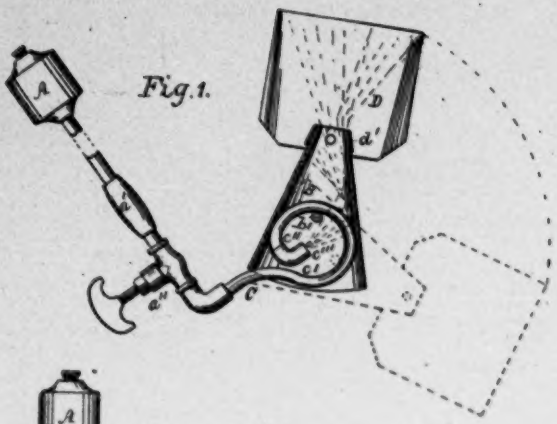


Fig. 2.

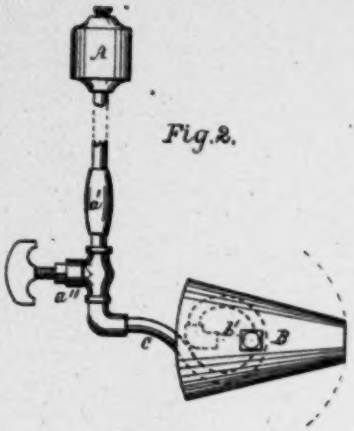


Fig. 3.

Witnesses:

Benj. Morison.

Wm. H. Morison.

Inventor.

John P. Hayes

UNITED STATES PATENT OFFICE.

JOHN P. HAYES, OF PHILADELPHIA, PENNSYLVANIA.

IMPROVEMENT IN PAINT-BREAMERS.

Specification forming part of Letters Patent No. **169,439**, dated November 2, 1875; application filed September 9, 1875.

To all whom it may concern:

Be it known that I, JOHN P. HAYES, of the city of Philadelphia, in the State of Pennsylvania, have invented an Improvement in Paint-Breamers, of which the following is a specification:

The object of my invention is twofold—first, to enable the operator to readily direct the flame-jet in any direction upward or downward, for the purpose of breaming under and upper horizontal or inclined surfaces, as well as such as are vertical; and, second, to protect at the same time, when desirable, side or other surfaces from the injurious effects of the hot flame.

The construction and mode of operation of my said invention will hereinafter be fully described with reference to the accompanying drawing, in which—

Figure 1 is a side view of a hydrocarbon-reservoir and jet-burner with a vertical section of my invention applied thereto; Fig. 2, a side view of the same reservoir, with the directing-tube in full, without the side protector; and Fig. 3 is a full view of the side protector detached.

The reservoir A, with its conduit-pipe *a'* and stop cock *a''*, is constructed in substantially the same manner as that shown in the patent granted to Ivory Hayes for a flame-protector, dated June 29, 1875, No. 164,996; but the burner end of the pipe C in my invention is bent into a more circular form from *c'* to *c''*, for the purpose of guiding and holding the tapering flame-tube B in its variable positions, as will be described.

The flame-tube B is first made in the form of a hollow conical frustum, and then the two opposite sides of the larger portion pressed toward each other, so as to give its transverse section the form of a flattened ellipse, for the purpose of causing it to receive within it the circular or retort portion *a' a''*, as shown in Fig. 1, and with the jet end *c'''* brought near to the center of said circular portion, so as to cause the flame-jet to project forward against the mid-length of the latter, for the purpose of heating it. The smaller end of the tube B is left circular, for the purpose of receiving over it the socket *d'* of the plate D, which is adjustable and detachable, for the purpose of defending side or such other surfaces as do not require to be breamed by the flame which may be acting near the same. Near the middle of the tube B there is a nutted screw-bolt, *b'*, which is inserted transversely through B, after the latter has been slipped over the coiled portion of the jet-burner pipe C, so that the side of said bolt *b'* will bear against the inner side of the curve *c' c''*, and thus keep the tube B from slipping off from pipe C when the latter is being moved or vibrated upward and downward in directing the flame-jet accordingly. (See Figs. 1 and 2.)

In Fig. 1 the protecting or defending plate D is shown applied to the burner-pipe C, so as to defend the vertical side—say of glass or painted wood—while the flame is operating upon the under side of the adjoining surface, and the dotted lines in the same figure indicate the same parts turned downward.

Fig. 2 shows the tube B directed horizontally without the defending-plate D, which can be applied at any time, and adjusted thereon so as to defend either vertical, under, or upper surfaces from the jet-flame, as occasion may require.

The construction, mode of operation, and utility of my said invention will be clearly understood and appreciated without any further description or explanation.

I claim as my invention—

1. The vibratile tube B, in combination with the flame-jet pipe C of a paint-breamer, the said tube and pipe being constructed and arranged to operate together, substantially in the manner and for the purpose set forth.

2. The protecting or defending plate D, in combination with the tube B, substantially in the manner and for the purpose hereinbefore set forth and described.

JOHN P. HAYES.

Witnesses:
BENJ. MORISON,
WM. H. MORISON.

I. KENDRICK.

MACHINES FOR MELTING SNOW AND ICE.

No. 184,628. Patented Nov. 21, 1876.

Fig. 1

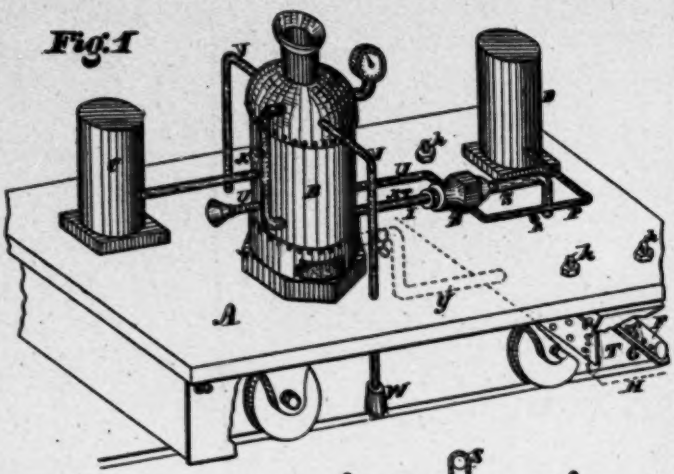
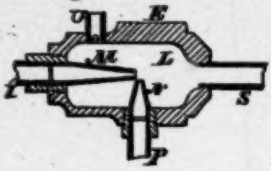


Fig. 2



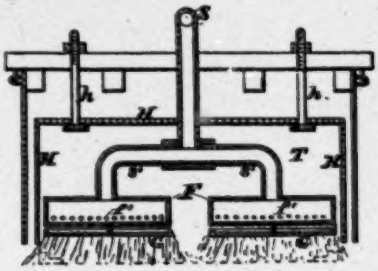


Fig. 3

Witnesses

Inventor

Attorneys

UNITED STATES PATENT OFFICE.

ISAAC KENDRICK, OF PHILADELPHIA, PENNSYLVANIA.

IMPROVEMENT IN MACHINES FOR MELTING SNOW AND ICE.

Specification forming part of Letters Patent No. 184,628, dated November 21, 1876; application filed February 19, 1876.

To all whom it may concern:

Be it known that I, ISAAC KENDRICK, of Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in Machines for Melting Snow or Ice; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it pertains to make and use it, reference being had to the accompanying drawings, which form part of this specification, in which—

Figure 1 is a perspective, partly broken away. Fig. 2 is a vertical longitudinal section of the atomizer. Fig. 3 is a transverse vertical section through the retort-burner.

My invention relates to an apparatus for removing snow or ice from railway-tracks or highways by the direct action of flame applied by a portable machine moving on wheels or runner.

My improved machine consists of a suitable car, truck, or platform mounted on wheels or runners, having a boiler for generating steam, a water-tank, and oil-reservoir thereon, in combination with an apparatus for atomizing, vaporizing, and burning petroleum, or its products, in a gaseous form.

In carrying my invention into effect, I employ a hollow or chambered casting of iron or other metal, of any suitable form, preferably cylindrical, the walls of which are perforated with one or more inlet holes or openings, through which steam, oil, and air are admitted. The rear end of this chambered casting is closed by a screw-plug or other device, through which an opening is made, to the inner extremity of which is fixed a short pipe or nipple. Another nipple is fixed to the inner end of an opening through the side wall of the chamber. Steam is admitted through the first nipple, and liquid hydrocarbons through the other, said nipples being arranged at or about right angles to each other, with their outlets in close proximity, so that the steam will atomize and vaporize the liquid hydrocarbons. At the same time a current of air, preferably heated, is drawn into the vaporizing and atomizing chamber, and thoroughly commingled with the steam and hydrocarbon vapors therein. I also employ a distributing retort and burner, consisting of a vessel or chamber of iron or other metal, preferably cylindrical in form, perforated with drill-holes on its under or lower side, through which the commingled steam, hydrocarbons, and air are made to issue in a gaseous form at the point of combustion.

I further make use of a bottomless combustion-chamber, the walls of which are constructed of cast-iron plates, boiler-iron, or other sheet metal, of any desired form, preferably rectangular. The front wall of this chamber may be hinged to the ceiling, forming a swinging door for easy access to the retort and burner. The end walls are perforated with small drill-holes for the admission of air to support combustion, and both said end walls and the side walls are made to extend down nearly to the roadway, so that the flame from the retort-burner after direct action upon the snow or ice surface may be for some period of time confined within said chamber, and utilized as a melting medium. Said chamber is suspended beneath the car or platform by means of iron rods secured or passing up loosely through the bottom of said car, so that said chamber may be raised or lowered when desired. Within this combustion chamber is placed the combined retort and burner already mentioned.

The highly-heated waste products of combustion may be, and in practice are, intended to be conveyed by a pipe from the rear end of the combustion-chamber to the fire-box of the boiler, and utilized for generating steam, thus greatly lessening the expense for fuel, or said waste products may be made to pass off

under the rear wall, and thus aid in melting the snow or ice.

A in the drawings represents a railway-car, truck, or platform on wheels; B, a boiler for generating steam. C is a water-tank, and D a reservoir for liquid hydrocarbon or its products. E is the atomizer, having a chamber, L, in which the liquid hydrocarbons and steam, or steam and air, are commingled, the steam entering through nipple M, oil through nipple N, and air through inlet or inlets O. F is the retort-burner, and G represents a pan, the purpose of which is to receive and retain any unvaporized oil that may escape from the retort, and prevent its being deposited along the roadway. H H show the walls which form the bottomless combustion chamber T, and *h* are iron rods by which said chamber is secured to and held in suspension beneath the car-body. I is a pipe for conveying steam from the boiler (preferably superheated by passing it through the fire-box) to the atomizer E. K K are valves for regulating the flow of the steam. P is a pipe through which oil is taken from the reservoir D to the atomizer E, the flow being governed by a cock, R. S is a pipe attached to the outlet of the atomizer, and through which, and branches *s'*, the mixed oil, steam, and air, in a vaporic condition, are conveyed to the retort-burner. *f* are drill-holes, through which the mixture issues in a gaseous form within the combustion-chamber. U is a pipe, through which air, preferably heated, so as to avoid condensation of the steam, is taken to the atomizer. V is a pipe, through which the excess or surplus steam from boiler B is conveyed to one or more rose-heads, W. Y is a pipe, by which the highly-heated waste products of combustion are conducted from chamber T to the fire-box of the boiler for generating steam.

The operation is as follows: A fire being started under the boiler, when steam of sufficient pressure is generated, the valves K are opened for the passage of steam through pipe I and nipple M. The cock R is then opened and oil admitted through pipe P and nipple N, and impinged and atomized by the steam entering through nipple M, and vaporized by the heat of the same in chamber L. At the same time a current of air is drawn in through pipe U and inlet O by the suction of the steam, and thoroughly mixed or commingled with the hydrocarbon vapors and steam, thus preparing it for purposes of fuel before reaching the point where ignited. The mixture is then conveyed by pipe S and branches *s'* to the retorts F, whence, after subjection to the heat of said retort, it issues through the drill-holes *f* in a gaseous form, at the point of ignition, within the combustion-chamber, and not in the form of spray, thus securing perfect combustion, and avoiding all danger of accident by reason of the distribution of burning oil along the roadway.

The burning hydrocarbon gas, under pressure of the boiler, acts as a powerful steam and air blast, and is delivered with great force directly upon the snow or ice, at the same time filling the combustion-chamber with an intensely-heated confined mass of flame, which also acts with great power upon an extended superficial area of snow-surface.

The highly-heated waste products of combustion pass off, at the rear end of the chamber T, by a pipe, Y, to the fire-box of the boiler, and are there utilized for generating steam, thus greatly lessening the cost of fuel for this purpose; or, if preferred, they may be made to pass off by an outlet through the lower edge of the rear wall, and thus aid in melting the snow and the ice.

In order to get rid of all noise arising from excess steam, or blowing off, I connect a pipe to the steam space of the boiler, and convey such surplus steam beneath the car, and discharge it in a divided condition, through one or more rose-heads, directly over the rails of a railway; or it may be discharged through a perforated pipe extending from side to side of the truck, and thus made to assist in melting the snow or ice. The melted snow, when desired, may be brushed away by an arrangement of revolving or stationary brooms upon the same or a separate truck.

I do not limit myself to the precise construction or arrangement of the devices above described, as it is manifest the same may be greatly varied and yet the principle of operation remain the same. For instance, the chambered atomizer may have more than one nipple for the admission of oil, and several air inlets; or it may be varied in form without changing its action. So, too, more than one atomizer, retort, and combustion-chamber may be placed upon the same platform, one being arranged, if desired, at each end, so that two fires may be brought to act upon the snow or ice at the same time; or that the machine may be drawn from either end without turning around. Further, the retort may extend entirely across the combustion-chamber, instead of being in two sections, as shown in Fig. 3.

It will be observed that in this apparatus the hydrocarbon is thoroughly vaporized by the force and heat of the steam, and mingled with air before being brought to the point of combustion; and that the gaseous product or mixture is consumed by means of a burner-retort located in a combustion-chamber, so that said retort, being constantly enveloped by a flame of intense heat, will itself be of such a temperature, as to convey a certain degree of fixity to the gas, preventing condensation, and insuring results altogether different from those obtained by simply burning liquid hydrocarbons with steam in an open or exposed condition.

I claim—

1. The combination, with a portable machine for melting snow or ice, of an atomizer for liquid hydrocarbons for purposes of fuel, as herein set forth.

2. The combination, with a portable machine for melting snow or ice, of a retort-burner, constructed and operating substantially as shown and specified.

3. In a portable snow or ice melting machine adapted for the employment of liquid hydrocarbons, as fuel, a bottomless combustion-chamber, T, constructed and operating substantially as shown and described.

4. In a portable machine for melting snow or ice, the combination, with the hydrocarbon combustion-chamber and boiler, of a pipe for conveying the waste products of the former to the latter, and utilizing the same for purposes of fuel, as set forth.

5. In a portable snow and ice melting machine, the combination, with the boiler B, of pipe V and rose-heads W, for getting rid of excess steam and utilizing the same, as set forth.

6. In combination with the retort-burner F, the pan G, substantially as shown and described.

7. The combination, in a portable snow or ice melting machine, of a hydrocarbon-atomizer, retort-burner, and combustion-chamber, with connecting-pipes and flow-regulating cocks, arranged to operate as set forth.

8. The combination, in a portable machine for melting snow and ice, of a steam generator, water-tank, oil-receptacle, liquid-hydrocarbon atomizer, retort-burner, and combustion-chamber, with connecting pipes and regulating-valves, constructed and arranged for operation substantially as herein shown and described.

In testimony that I claim the foregoing I have hereunto set my hand this 14th day of February, 1876.

ISAAC KENDRICK.

Witnesses:

M. DANL. CONNOLLY,

CHAS. F. VAN HORN.

(No Model.)

A. F. ZIMMERLING.

COMBINED SMOOTHING, FLUTING, AND POLISHING IRON.

No. 269,368. Patented Dec. 19, 1882.

Fig. 1.

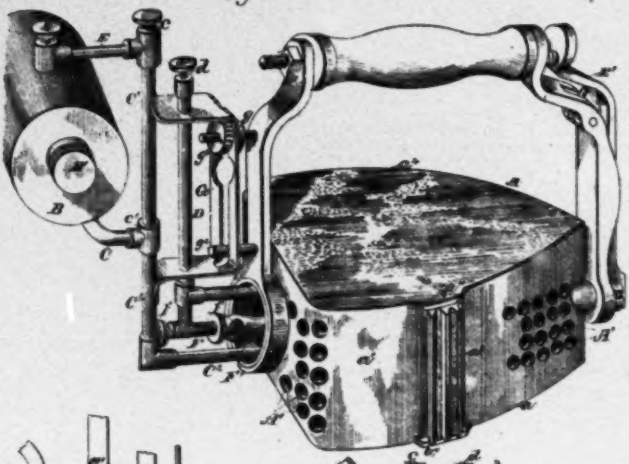


Fig. 2.

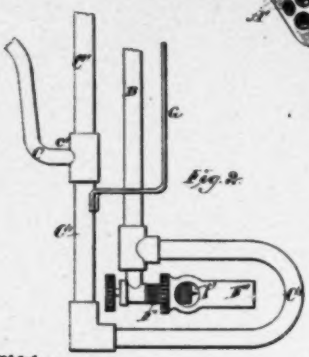
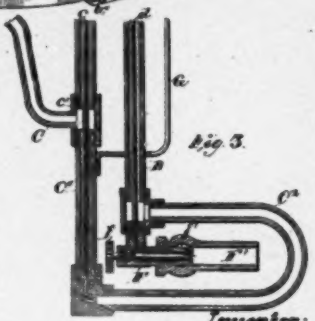


Fig. 3.



Witnesses:
E. Klemm
Carl Pickhardt.

Inventor:
August F. Zimmerling
By
Stout & Anderson
Attorneys

UNITED STATES PATENT OFFICE.

AUGUST F. ZIMMERLING, OF MILWAUKEE, WISCONSIN.

COMBINED SMOOTHING, FLUTING, AND POLISHING IRON.

SPECIFICATION forming part of Letters Patent No. 269,368, dated December 19, 1882.

Application filed April 8, 1882. (No model.)

To all whom it may concern:

Be it known that I, AUGUST F. ZIMMERLING, of Milwaukee, in the county of Milwaukee, and in the State of Wisconsin, have invented certain new and useful Improvements in a Combined Smoothing, Fluting, and Polishing Iron; and I do hereby declare that the following is a full, clear, and exact description thereof.

My invention relates to laundry-irons; and it consists in a combined article for smoothing, fluting, and polishing, together with a device for heating the same, all as more fully set forth hereinafter.

In the drawings, Figure 1 is a perspective view of my entire device. Fig. 2 is an elevation of the lower part of the heating device, and Fig. 3 is a vertical longitudinal section of the same.

My present invention is, in part, an improvement on that patented to me on the 9th day of August, 1881, and numbered 245,336, and, like that device, has a four-faced hollow iron, A, two of the faces, *a a*, being perfectly flat and designed for ordinary smoothing, while the face a' is intended for fluting, and the face a^2 for polishing linen. In this present case, however, instead of corrugating the entire face a', as in the patent referred to, I have simply made a corrugated roller, a^3, which is journaled in lugs a^4 a^4, and extends transversely across the face a', while the polishing-surface a^2, instead of being made, as formerly, with a rounded heel simply, is here shown with its entire surface curved, so that it may be used as a polisher at any point, instead of only at its rear edge, as in the patent named. These points of difference are of minor importance; but I have found by actual experiment that they possess advantages over the construction shown in my said patent. The handle and locking device are formed substantially as in my said patent, and therefore do not call for an extended description here. The heating device, however, is very different in its construction and mode of operation from that shown in my said patent, and I not only attach it in a somewhat different manner, as hereinafter described, but I have also changed the position of the air-holes A′, as shown, so as to insure freer combustion within the iron, by perforating the iron near its point as well as at the rear, instead of at the rear only, as in my said patent.

B is the reservoir, which is filled from the end instead of the upper surface, the opening being covered and protected by the screw-cap B′.

C C′ C² constitute the system of feed-tubes, the first being designated the "branch," the second the "straight" tube, and the third the "bent" tube. D is the regulating-tube, and E the gas-escape tube. F F′ is the blow-pipe. There are four valves in my present device—namely, the feed-valve *c* in the tube C′, the regulating-valve *d* in the tube D, the gas-valve *e* at the end of the tube E, and the setting-valve *f* in the blow-pipe. Wherever any of the said tubes unite, or where they receive branches, I prefer to employ screw-threaded couplings, as shown, though it is obvious that my system of tubes could be cast solidly, if desired, without departing from my invention, although at a greater expense, and with no increased efficiency, but rather less, as I am now enabled to take my device apart should any one of the numerous tubes or valves get out of order.

The reservoir being filled with the preferred fluid—such as alcohol, naphtha, or other gaseous liquid—the feed-valve *c* is screwed upward, which opens the passage from C′ to C², and the fluid descends through the branch C to the straight tube C′, and thence through the bent tube C² into the base of the regulating-tube D, and thence into the blow-pipe F F′, and a light being applied to the burner or outer end of the part F′ the fluid takes fire. In a very few seconds the bent part of the tube C² becomes heated from the flame, and then all the fluid that reaches this point becomes converted into dry gas, in which form it passes into the blow-pipe, just as first the fluid did, to support the flame. The heating device is then adjusted within the iron, and in an exceedingly short time the iron is heated sufficiently for the service required. As the tendency of the flame is principally forward and upward, the point and uppermost surface of the iron is always kept hot, requiring only an occasional

reversing of the smoothing-surface, in ordinary ironing, whenever the operating-surface shall have become too cool, and this reversal is to be accomplished by means of the spring-catch E', here shown, and described at length in my patent already named, whereby, also, the iron may at any time be instantly set so that any face desired may be in proper position for use, and meanwhile the face above and the point and sides of the iron will be getting heated in turn.

The blow-pipe consists, as indicated, of two parts, F and F'. The former communicates directly with the regulating-tube D, through which it receives its supply of gas, (produced, as stated, from the fluid in the bent tube C^3 by the heat of the flame,) and it is screw-threaded on its outer exterior end to receive the part F', which has two air-holes, f', near the end farthest from the burner. If very great heat is desired the part F' may be screwed forward, so as to more fully open these air-holes f' and increase the draft, and hence the combustion, whereas if less heat is required the part F' may be screwed backward, thereby partially closing the air-passages f'. The setting-valve f controls the quantity of gas which passes to the burner; but this valve requires but little change in position, as this result can be obtained under all ordinary circumstances by screwing the regulating-valve d up or down, as required. It will be understood that the four valves c, d, e, and f are identical in construction, (except that they differ in length,) each valve being screw-threaded just below its head, and turning in interior screw-threaded bearings (properly packed, if required) at the upper or closed end of the tube, while each valve is pointed or tapered off at its other end to fit into a correspondingly-tapered socket, so that by turning the head of the valve slightly the said valve may be screwed up or down, as required, and the space between the tapering end of the valve and its tapering seat may be increased or diminished (even to the entire closing of the passage) at will, all as clearly indicated by the sectional view, Fig. 3.

The function of the gas-escape tube E and gas-valve c remains to be described. The fluid in the bent tube C^3 becoming heated by the flame at the end of the blow-pipe expands into gas, as already described, and as this gas is formed faster than it can be consumed the balance naturally seeks an exit. The regulating-tube D being closed at its upper end, the only way of escape is back through the bent tube C^3, and thence directly up the straight tube C'. Now, as fluid is all the time flowing from the reservoir B through the branch C into the straight tube C', the said branch C is always full, and the gas cannot therefore pass into said branch, and so it continues past the coupling-point c' straight up to the top of the tube C' and out into tube E, and thence into the upper part of the reservoir B, above the fluid, the tube E being on a horizontal line below the screw-seat of the valves c and e, and therefore affording a free passage for the gas from the tube C' to the reservoir, which, however, can at any time be closed, if desired, by screwing down the gas-valve c into its socket. The effect of this heated gas on top of the fluid in the reservoir B is not only to exert a slight pressure, which insures a constant flow of said fluid out through the branch C and the other feed-tubes, but, also, it prevents a vacuum being formed in the reservoir, and compels the fluid and gas to balance each other, as it were, the system of tubes being thus always filled with fluid and gas while the iron is in operation.

The heater is secured in place on the iron by means of its slotted plate G, which receives the flanged bolt g and its nut g', and also the pin g^2, the said bolt and pin projecting from the rear shank of the handle of the iron, and when in place the nut g' can be screwed tight, while the pin g^2 prevents any swing to the lower part of the heater, thus forming a much more secure and effective lock than the plate with simple key-hole slots, which I showed in my patented device hereinbefore named.

Although I have referred to my invention as an improvement in laundry-irons, I wish it understood that it is equally well adapted for tailoring and dress-making, or any other business requiring the smoothing, polishing, or fluting of fabrics.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In a heater for combined laundry-irons, the combination of the reservoir B and system of feed-tubes C C' C^3, the feed-valve e, and the blow-pipe F F' and regulating-valves, substantially as described, and for the purpose set forth.

2. In a heater for combined laundry-irons, the combination of the fluid-reservoir B and its branch C with the blow-pipe F F', bent tube C^3, straight tube C', and gas-escape tube E, whereby the unconsumed gas that is formed in the bent tube C^3 may have passage-way into the reservoir and prevent a vacuum being formed therein above the fluid, as set forth.

3. In a heater for combined laundry-irons, the combination of the reservoir B, branch C, straight tube C', feed-valve e, bent tube C^3, regulating-tube D, regulating-valve d, and blow-pipe F F', as shown and described, and for the purpose set forth.

4. In a heater for combined laundry-irons, the combination of the reservoir B, feed-tubes C C' C^3, regulating-tube D, gas-escape tube E, blow-pipe F F', and valves c d e f, as shown and described, and for the purpose set forth.

5. In combination with the rear shank of the handle of a hollow reversible laundry-iron provided with the flanged bolt g and pin g^2, a heating device provided with the plate G, slotted as described, whereby it may pass over the flanged bolt, and a nut g', to tighten

the plate to place, while the pin g^2 prevents any lateral movement or swing to the lower part of the heater, as set forth.

6. In a heater for combined laundry-irons, the blow-pipe described, consisting of the part F, having setting-valve *f*, and screw-threaded on its outer end, in combination with part F', having interior screw-threads at its rear to fit over the part F, and air-holes next to its threaded portion and farthest from its burner, as and for the purpose set forth.

In testimony that I claim the foregoing I have hereunto set my hand on this 21st day of March, 1882, in the presence of two witnesses.

AUGUST F. ZIMMERLING.

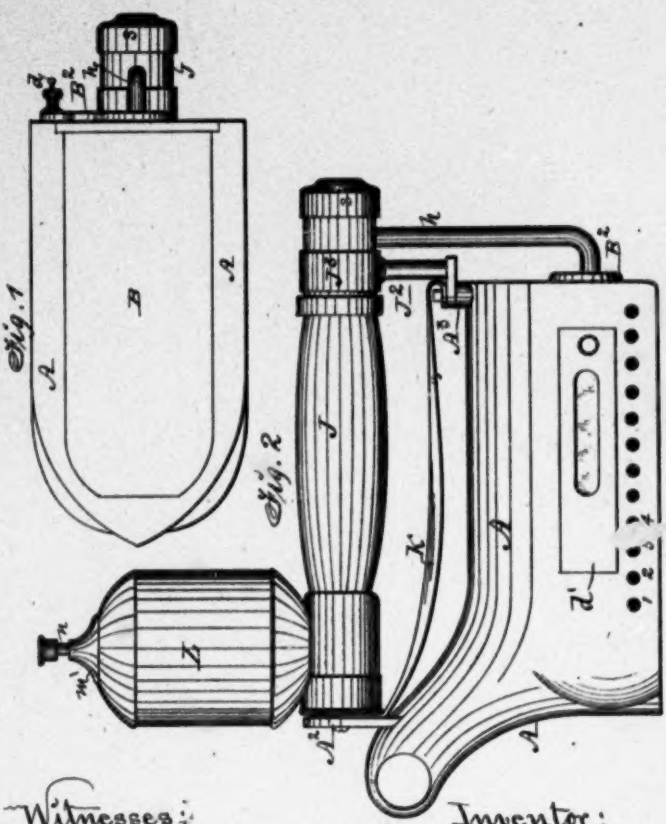
Witnesses:
STANLEY S. STOUT,
HAROLD G. UNDERWOOD.

(No Model.) 2 Sheets—Sheet 1.

J. B. CURL.

SELF HEATING FLAT IRON.

No. 383,346. Patented May 22, 1888.



Witnesses:
M. P. Smith
J. C. Tate

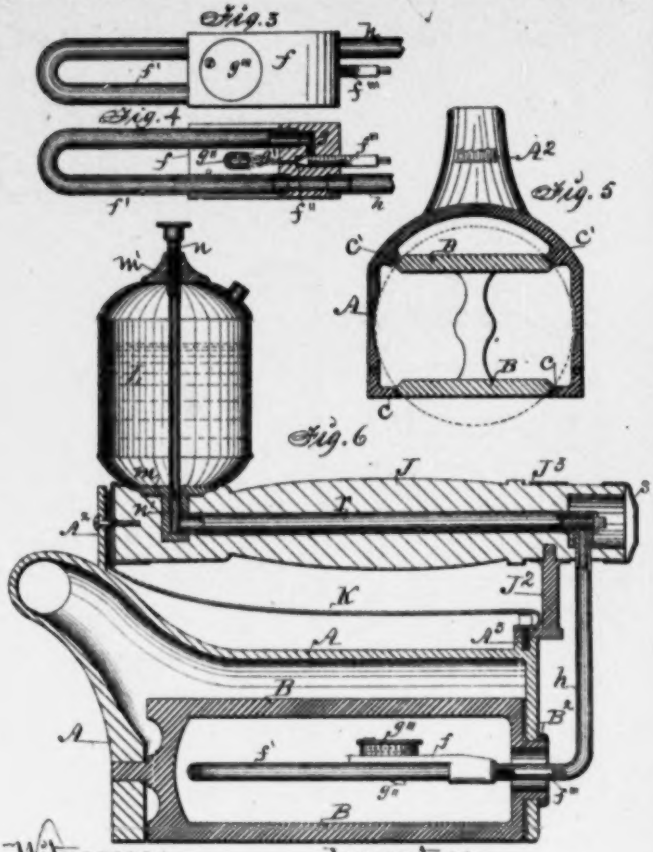
Inventor:
Jesse B. Curl,
By Thomas G. Orwig, Atty.

(No Model.) 2 Sheets—Sheet 2

J. B. CURL.

SELF HEATING FLAT IRON.

No. 383,346. Patented May 22, 1888.



Witnesses:
M. P. Smith.
J. C. Tal-

Inventor:
Jesse B. Curl,
By Thomas G. Orwig, Atty.

UNITED STATES PATENT OFFICE.

JESSE B. CURL, OF DES MOINES, IOWA.

SELF-HEATING FLAT-IRON.

SPECIFICATION forming part of Letters Patent No. 383,346, dated May 22, 1888.

Application filed August 30, 1887. Serial No. 248,385. (No model.)

To all whom it may concern:

Be it known that I, JESSE B. CURL, a citizen of the United States of America, and a resident of Des Moines, in the county of Polk and State of Iowa, have invented an Improved Self-Heating Flat-Iron, of which the following is a specification.

My invention consists in the construction and combination of a duplex revolving bottom, a vapor generator and burner, an oil-reservoir, and a handle, with a hollow open-bottomed iron, as hereinafter set forth, pointed out in my claim, and illustrated in the accompanying drawings, in which—

Figure 1 is a bottom view, and Fig. 2 a side view, of my improved iron. Fig. 3 is a top view, and Fig. 4 a bottom view, of my vapor generator and burner. Fig. 5 is a transverse view and Fig. 6 a longitudinal view, each taken through a central line.

A represents a cast-metal hollow and open-bottomed iron that may vary in dimensions, as desired. It has an integral tubular extension or chimney at its front end.

A^1 is a vertical projection at the top of the chimney, and A^2 a projection at the top and rear of the iron, to which a wooden handle is attached.

B is my duplex revolving bottom, corresponding in size with the interior chamber and open bottom of the iron A. It has a solid journal on its front end and a hollow journal on its rear end, fitted in corresponding bearings in the ends of the iron, as clearly shown in Fig. 6, in such a manner that it can be readily revolved, as indicated by dotted lines in Fig. 5, by means of a crank, B^1, fixed to the end of the hollow journal at the rear end and outside of the iron A.

c c are flanges at the bottom of the iron, and c' flanges at the base of the roof, that project inward, as clearly shown in Fig. 5, to connect with the two revolving bottoms when they are in level horizontal position, as required to close the iron at the bottom and to produce a horizontal partition in the top portion of the iron that will serve as a deflector to direct the products of combustion forward and in contact with the under side of one of the parts of the revolving bottom, while at the same time a vacant space is retained under the roof that will prevent the top of the iron from becoming unduly heated.

d, shown in Fig. 1, represents a locking device in the form of a spring-actuated pin that extends through the crank-handle B^1 into a perforation in the end of the iron. To unlock the handle, I draw the pin outward to free its inner end from the iron.

d' is a door and window in the side of the iron, through which access is gained to the interior. A series of perforations, 1 2 3 4, under the door admit air to the burner inclosed within.

f is the cast-metal base of my vapor generator and burner. It has an enlargement at its rear end and under side, into which tubes are fitted, as clearly shown in Figs. 4 and 6.

f' is a coil or U shaped tube that has its ends fitted and fixed in bores formed in the base, through which oil is conducted into the base to become heated and vaporized.

f'' represents a screw seat and valve chamber, and *f'''* a valve fitted in said chamber to govern the flow of the fluid and the discharge of the vapor.

g is a bore that intersects the valve-chamber *f''* and communicates with one end of the bent tube *f'*.

g' is a vent from which fluid and vapor are discharged from the valve-chamber *f''*.

g'' is an open-ended bent tube that extends through the metal base, to which it is fixed in such a manner that its open bottom end will be in line with the discharge-vent *g'*.

g''' is a perforated cap and burner fixed over the open top of the open tube *g''*, by means of a screw, in such a manner that the vapor will be distributed thereby and mixed with the air as required to be burned advantageously in maintaining a uniform heat in the iron.

h is an induction-tube, through which fluid is conveyed through a bore in the base *f* of the generator into the tube *f'*, and from thence into the valve-chamber *f''*, formed in the said base *f*, as clearly shown in Fig. 4.

J is a wooden handle fixed to the projection A^1 by means of a screw and the projection A^2 by means of a post, J^1, and a screw and a band, J^2, as shown in Fig. 6.

K is a hand-shield jointly fastened with the handle J, as required, to protect the operator's hand.

L represents an oil-reservoir fixed on top of the front end of the wooden handle. It has a

cast-metal bottom, *m*, and a cast-metal top, *m'*, through which a screw or valve-stem, *n*, is extended into a vertical bore or valve-chamber, *n'*, formed in the bottom *m*, as clearly shown in Fig. 6, in such a manner that the flow of liquid from the reservoir can be readily governed thereby.

r is a straight tube extended through a bore in the wooden handle and screwed into a bore in the bottom *m* of the reservoir that intersects the vertical bore and valve-chamber *n'*. A square end on the straight tube and an enlargement of the bore in the wood facilitates the fastening of the tube by means of a wrench. A cap, *s*, fitted over the end of the wooden handle conceals the bore and tube. The elbow-shaped tube *h* is connected with the generator *f* at its lower end and with the tube *r* at its top end, as shown in Fig. 6.

In the practical use of my iron the flow of gasoline, or other suitable fluid, from the reservoir to the vapor generator is readily controlled by means of the screw or valve *n* in the top of the reservoir, and the discharge of fluid and vapor from the generator is readily regulated by means of the screw or valve *f''''* in the end of the generator.

To start a fire, I open the valve *f''''* and allow a small quantity of fluid to flow and then light it with a match, so that the fluid will burn under the generator and heat and vaporize the fluid therein until it will begin to discharge vapor. I then, by means of the valve, regulate the discharge of the vapor as required to force it up through the tube *g''* into the burner *g'''*, from whence it will escape and burn as required to heat the upper portion of the duplex revolving bottom B; and when it is hot enough I reverse the position of the bottoms and utilize the heated one in a common way while the other one is becoming heated. The two bottoms can be thus successively heated and the iron continuously used by merely interchanging the positions of the connected revolving bottoms as long as there is fluid in the reservoir. To put out the fire, I simply close the valve in the generator.

I claim as my invention—

An improved self-heating iron comprising an open-bottomed hollow iron having a chimney at its front end and journal-bearings at its opposite ends, a duplex bottom having journals on its ends and a crank on the end of one of said journals, a wooden handle having an oil-reservoir on its top connected by means of tubing with a vapor generator and burner located and concealed within the hollow iron and double revolving bottom, and valves for regulating the flow of fluid in the reservoir and in the vapor-generator, constructed, arranged, and combined to operate in the manner set forth.

JESSE B. CURL.

Witnesses:
MARTIN P. SMITH,
THOMAS G. ORWIG.

(No Model.) 2 Sheets—Sheet 1.

A. H. PERKINS.

APPARATUS FOR REPAIRING ASPHALT PAVEMENTS.

No. 501,536. Patented July 18, 1893.

Fig. 1.

Fig. 2.

Witnesses
[illegible]

Inventor
A. H. Perkins
by Edmund W. Burke & Co
Attys.

4214

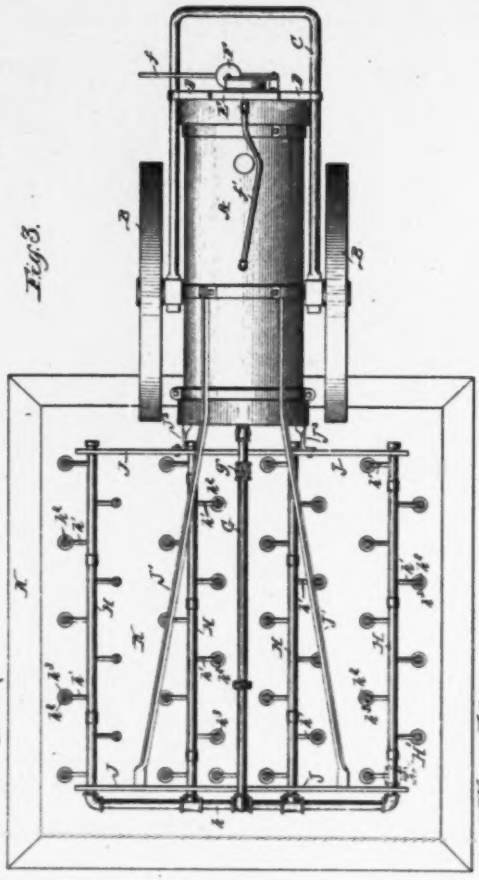
(No Model.) 2 Sheets—Sheet 2.

A. H. PERKINS.

APPARATUS FOR REPAIRING ASPHALT PAVEMENTS.

No. 501,536. Patented July 18, 1893.

Fig. 3.



Witnesses.
Wm. M. Blume
Wm. F. Fleming

Inventor.
A. H. Perkins
By Dyer & Co. Taylor
Attys.

UNITED STATES PATENT OFFICE.

AMOS H. PERKINS, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE WESTERN PAVING AND SUPPLY COMPANY, OF SAME PLACE.

APPARATUS FOR REPAIRING ASPHALT PAVEMENTS.

SPECIFICATION forming part of Letters Patent No. 501,536, dated July 18, 1893.

Application filed March 8, 1893. Serial No. 465,136. (No model.)

To all whom it may concern:

Be it known that I, AMOS H. PERKINS, a citizen of the United States, residing at Chicago, county of Cook, State of Illinois, have invented a certain new and useful Improvement in Apparatus for Repairing Asphalt Pavements; and I declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it pertains to make and use the same, reference being had to the accompanying drawings, which form a part of this specification.

My invention has for its object the production of a portable apparatus for heating the surface of asphalt pavements and is for use more particularly in connection with my improved method of repairing asphalt pavements, an application for which was filed March 8, 1893, Serial No. 465,137. It consists in a combination of devices and appliances hereinafter described and claimed.

In the drawings, Figure 1 is a side elevation of my apparatus. Fig. 2 is a rear elevation of the same. Fig. 3 is a plan view.

In the device employed in carrying out the invention A represents a tank mounted upon suitable wheels B and provided with a suitable handle C. At one end of the tank supported by the braces D which are engaged to the handle, is the board E. On this board is an air pump F provided with a suitable operating handle *f* with an outlet pipe *f'* which leads into the top of the tank. From the bottom of the tank and adjacent to the opposite end is an outlet pipe G provided with a valve *g*.

H represents a series of horizontal pipes, four in number, connected together at one end by the pipe *h* and supported by the cross bars or braces J, the latter being supported from the tank by the braces J', J². Each of the pipes H may be supplied with a valve H' as indicated by dotted lines in Fig. 3 for cutting out all the burners thereof simultaneously. Extending from each of the horizontal pipes H are short pipes or spurs *h'* and at the end of each of these is a burner *h²* of any desired construction. Preferably these burners are of the form usually employed for producing a blast with a gasoline vapor flame. Each of the burners is controlled by its own valve *h'*. Supported by and depending from the cross bars J is a hood or shield K, each burner passing through an orifice in this hood and projecting beneath the same. Each orifice through which each burner passes is somewhat larger than the burner so that plenty of oxygen may be supplied to the burner and thus insure proper combustion. It will now be seen that by filling the tank with gasoline and maintaining plenty of pressure above the same a strong blast may be obtained at each of the burners. Connecting with the pipe *f'* is a pressure gage M so that the operator can easily watch the pressure and maintain sufficient in the tank.

The operation will be easily understood. As many of the burners as it is desired to use are turned on and the operator grasping the handle moves the apparatus which easily balances on the wheels, to the point where the spot to be repaired is located placing the burner above the spot. The blast soon heats the pavement to the desired condition when the apparatus can be moved to another spot. If the spot is too large to be covered by the burners at one time the outer edge of the spot is first subjected to the blast and the apparatus then drawn, wheels first, across the balance of the spot, thus leaving that portion that has already been subjected to the blast to be operated upon by another hand.

It is obvious that many details of the apparatus might be altered or dispensed with, such for instance as the substitution of petroleum oil or other fuel, a variation in the number or form of the burners, and many other features, without affecting the essence of my invention which lies in the production of a portable apparatus for subjecting an asphalt pavement to a blast of heat after the pavement has been laid.

What I claim is—

1. In an apparatus for repairing asphalt pavements, the combination of a series of burners and means for movably supporting the same in close proximity to the pavement, substantially as described.

2. In an apparatus for repairing asphalt pavements, the combination of a series of hooded burners and means for movably supporting the same in close proximity to the pavement, substantially as described.

3. In an apparatus for repairing asphalt pavements, the combination of a series of hooded fluid burners, and a reservoir for supplying fuel thereto, said reservoir and burners mounted on a wheeled frame and the burners supported in close proximity to the pavement, substantially as described.

4. In an apparatus for repairing asphalt pavements, the combination with a series of hooded fluid burners supported in close proximity to the ground, a reservoir for supplying fuel to the burners, and means for applying pressure to the fuel to force it to the burners, of a wheeled frame carrying said apparatus, substantially as described.

5. In an apparatus for repairing asphalt pavements the combination of a fuel reservoir, a pump for exerting a pressure on the fuel therein, a series of burners connected with a series of horizontal pipes which are connected with the reservoir, and a plate forming a hood or shield through which each burner passes, the orifice around each burner being somewhat larger than the burner itself, substantially as described.

AMOS H. PERKINS.

Witnesses:
TODD MASON,
O. R. BARNETT.

626

(No Model.)

A. H. PERKINS.

METHOD OF REPAIRING ASPHALT PAVEMENTS

No. 501,537 Patented July 18, 1893

UNITED STATES PATENT OFFICE.

AMOS H. PERKINS, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE WESTERN PAVING AND SUPPLY COMPANY, OF SAME PLACE.

METHOD OF REPAIRING ASPHALT PAVEMENTS.

SPECIFICATION forming part of Letters Patent No. 501,527, dated July 18, 1893.

Application filed March 8, 1893. Serial No. 465,197. (No model.)

To all whom it may concern:

Be it known that I, AMOS H. PERKINS, a citizen of the United States, residing at Chicago, county of Cook, State of Illinois, have invented a certain new and useful Improvement in the Method of Repairing Asphalt Pavements; and I declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it pertains to make and use the same, reference being had to the accompanying drawings, which form a part of this specification.

My invention is designed to produce a method whereby the repairing of asphalt pavements may be quickly and cheaply accomplished and a neater appearing pavement be obtained after repairing than has heretofore been the case.

Heretofore in the repairing it has been customary to dig out with a pick or other instrument the surface material around the spot to be repaired, sometimes applying heat to the spot to soften the material so that it may be more easily removed. When the material has been removed the depression thus made is thoroughly cleaned and given a coat or dressing of tar. New material in a heated state has then been placed in the depression and been ironed down and smoothed off in the usual manner of finishing, the tar acting as a solder to hold the new material in place. When completed, however, the line or joint between the old hardened material and the new material has been plainly discernible and more often there has been more or less of a ridge. Again this new block of material by reason of frost or from other causes is frequently torn loose from its soldered connection with the old material thus necessitating new repairs. In practicing my invention however I subject the spot to be repaired and the surrounding edges to such a degree of heat that the surface asphalt, not only the exact spot to be repaired but the surrounding portion to a greater or less degree, is reduced to the soft pliable state in which it is originally laid. With a rake or other suitable instrument it is then agitated and mixed with enough new material to fill up the spot to be repaired. It is then subjected to the usual finishing operation of ironing and burnishing. The heating of the surface may be accomplished in various ways and by means of various forms of apparatus and while I have herein shown but one form for accomplishing the result, yet I would have it understood that I do not limit myself to any particular form of apparatus for carrying out my invention.

In the drawings Figure 1 represents a side elevation; Fig. 2 an end elevation of an apparatus for heating the pavement after it is laid.

In carrying out the invention A represents a suitable tank for carrying gasoline mounted on the wheeled frame B and connected by the pipe C with a series of horizontal pipes D. These pipes D carry a series of burners E which pass through a hood or shield F and project a flame downward against the pavement. Pressure is then obtained upon the gasoline to force it to the burners and to produce a blast by means of an air pump G mounted upon the tank.

The apparatus is also provided with a handle H whereby the operator may readily move it to the desired spot. Now as would be seen by turning on as many of the burners as are desired a strong blast of heat is projected against the surface of the asphalt and readily melts it. As explained above when it is desired to repair a spot the apparatus is moved adjacent thereto with the burners directly above the spot. These soon reduce the surface asphalt both at the spot and at the surrounding edges to a pliable state, the strong blast causing not only the immediate surface, but the particles deep down to be melted and yet not burned. With a rake or other suitable instrument the operator then agitates or stirs up the softened material and by adding new material of substantially the same degree of softness the spot or depression to be repaired is filled up and subjected to the usual smoothing and finishing operation as in the case of a new pavement. This, as will be seen, is done without the use of the tar for the purpose of uniting the parts or sections of material and is done without any distinct dividing line between the old and new material. In fact, there is no dividing line because the new material has been mixed with and be-

comes a part of the old material. As stated above while heating the spot to be repaired the surrounding edges or portions must be heated to a greater or less degree and the new material is worked into those edges as well as in the spot to be repaired so that when hardened it is practically impossible to tell where the pavement has been repaired.

What I claim is—

1. The method of repairing asphalt pavements which consists in subjecting the spot to be repaired to heat adding new material and smoothing and burnishing it, substantially as described.

2. The method of repairing asphalt pavements which consists in subjecting the spot to be repaired to heat until the material is softened, agitating it and mixing with it new material and finally smoothing and burnishing it, substantially as described.

AMOS H. PERKINS.

Witnesses:
TODD MASON,
O. R. BARNETT.

12146

(No Model.)

A. H. PERKINS.

METHOD OF AND APPARATUS FOR REPAIRING ASPHALT PAVEMENTS.

No. 517,191. Patented Mar. 27, 1894.

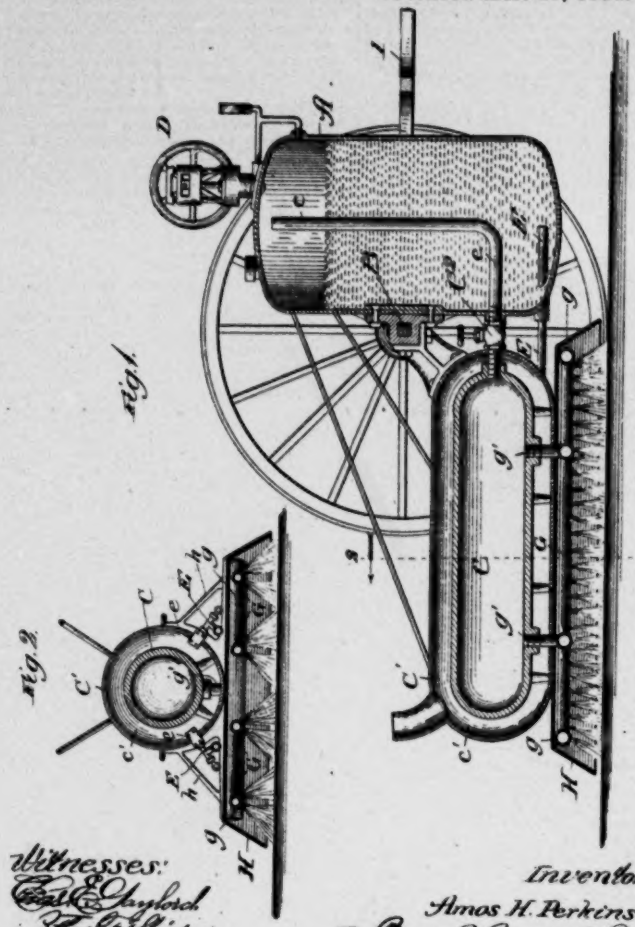


Fig. 1.

Fig. 2.

Witnesses:
Chas. E. Gaylord.
Thos. L. Shipman

Inventor:
Amos H. Perkins.
By Banning & Banning & Gaylord
Attys.

UNITED STATES PATENT OFFICE.

AMOS H. PERKINS, OF CHICAGO, ILLINOIS.

METHOD OF AND APPARATUS FOR REPAIRING ASPHALT PAVEMENTS.

SPECIFICATION forming part of Letters Patent No. 517,191, dated March 27, 1894.

Application filed September 20, 1892. Serial No. 446,012. (No model.)

To all whom it may concern:

Be it known that I, AMOS H. PERKINS, a citizen of the United States, residing at Chicago, Illinois, have invented certain new and useful Improvements in Methods of and Apparatus for Repairing Asphalt Pavements, of which the following is a specification.

The object of my invention is to provide a simple, economical and efficient method of and apparatus for repairing asphalt pavements, and it is particularly designed to be an improvement upon the method and apparatus shown in Letters Patent Nos. 501,536 and 501,537, granted to me July 18, 1893; and my invention consists in the details, combinations and arrangements hereinafter described and claimed.

In the drawings, Figure 1 is a side elevation, partly in section, of an apparatus for carrying out my invention; and Fig. 2 a transverse section taken on line 2 of Fig. 1, looking in the direction of the arrow.

In the methods of repairing now in ordinary use, it is customary to dig out or pick the surface of the material around the spot to be repaired. When the material has been removed, the cut thus made is cleansed and supplied with a new body of material. The new material is applied in a heated state, and smoothed and ironed down in the usual manner, the tar acting as a binding agent to hold the same in place. This method, however, leaves a line or ridge between the old hard material and the new material, which is plainly discernible and more or less of a detriment to the pavement.

In the use of my improvements, as shown and described in the Letters Patent above referred to, there is more or less danger of burning the material on the immediate surface from the contacting flames, before the particles deep down have been softened or melted. To obviate these objections, and at the same time provide an efficient method of and apparatus for repairing asphalt pavements are the principal objects of my invention.

In the preferred form of carrying out my invention, as illustrated by the drawings, I provide a suitable tank, A, for holding the gasoline, mounted on a wheel frame, B. Secured to and supported by the tank is an elliptical-shaped cast-iron cylinder, C, for the reception of air, connected to and communicating with the air space of the tank by means of a small pipe, *c*, so that the air which is supplied to the tank under pressure, by means of an air pump, D, is allowed to enter the elliptical-shaped cylinder. I surround this elliptical-shaped cylinder with an outer jacket or envelope, C′, preferably made of wire cloth and asbestus material, which leaves a heating chamber, *c′*, between it and the cylinder. I provide a set of oil supply pipes, E, which connect with the gasoline in the tank, and provide these pipes with a series of burners, *e*, arranged in such manner that the gasoline or oil which is supplied to them under pressure is ignited and projected against the cast-iron surface of the cylinder, C. The flame during its burning almost envelops the same in the chamber between the cylinder and the outer envelope, in such manner as to heat the cylinder to a very high temperature, and also the air contained therein.

I provide a set of horizontal pipes, G, which are connected to each other by a set of manifolds, *g*, connected to the cylinder and supported by two pipes, *g′*, in such manner as to be from about four to six inches above the pavement. These horizontal pipes are provided with a number of perforations, arranged in such manner as to project the heated air against the pavement at an angle of about forty five degrees. I inclose and cover these horizontal pipes by a metallic hood, H, which may be covered with asbestus material, so as to confine the heated air to as small a space as possible and against the surface of the pavement to be softened. This hood is supported in position, preferably contacting the jacket, C′, which surrounds the elliptical cylinder, by means of stay rods, *h*, leaving the bottom edges but a slight distance above the pavement. I provide the apparatus with a handle, I, whereby the operator may readily move it to any desired spot.

The method of repairing asphalt pavements by my process, and the operation of the apparatus are about as follows: The tank is supplied with a sufficient quantity of gasoline, or other liquid hydro-carbon, and air under pressure is forced into the tank by means

of the air pump, D, which forces the liquid hydro-carbons through the supply pipes to the burners, which are immediately ignited—the flame surrounding the cast-iron cylinder, thereby super-heating the air contained therein. When the air has reached the desired temperature, the operator opens the valve, c^3, on the air supply pipe, c, and air under pressure immediately enters the elliptical-shaped cylinder, forcing the hot air down into the horizontal pipes, G, with considerable pressure—say, about sixty pounds to the square inch—and against the heated pavement. The air in passing through the cylinder from the tank is immediately superheated and forced out through the horizontal pipes against the pavement, thereby furnishing a continuous supply of hot air to the pavement. This blast of heated air against the surface of the asphalt readily and easily softens the surface of the same, without any danger whatever of burning, until it has become sufficiently softened, when the apparatus is removed to a different location. The material thus softened is agitated by means of a rake, or other suitable instrument, and the requisite amount of new material of the same degree of softness is added to the spot or depression to be repaired and subjected to the usual smoothing and finishing operation, as in the case of a new pavement. This can be done without the use of any more tar for the purpose of uniting the parts or sections of the material, and is completed without any material line of demarkation between the old and new material.

While I have described more or less minutely the details of my invention, I do not desire to be limited unduly thereto, any more than is pointed out in the claims. On the contrary, I contemplate variations in form, construction and arrangement, and the use of equivalents, as circumstances may suggest or necessity render expedient.

I claim—

1. The method of repairing asphalt pavements, which consists in subjecting the part to be repaired to a blast of super-heated air, adding new material, and smoothing and burnishing it, substantially as described.

2. In apparatus for repairing asphalt pavements, the combination of a receptacle for containing air under pressure, means for super-heating the same, and means for projecting the heated air against the pavement, substantially as described.

3. In apparatus for repairing asphalt pavements, the combination of a receptacle for containing air under pressure, means for super-heating the same, means for projecting the heated air against the pavement, and means for confining the heated air in position against the pavement, substantially as described.

4. In apparatus for repairing asphalt pavements, the combination of a metallic receptacle for containing air under pressure, means for furnishing a supply of air under pressure to the receptacle, means for super-heating the same, means for projecting the heated air under pressure against the pavement, and means for confining the super-heated air in position against the pavement, substantially as described.

5. In apparatus for repairing asphalt pavements, the combination of a receptacle for containing air under pressure, a set of horizontal perforated pipes connected with the receptacle and held in position above the pavement, means for furnishing a supply of air under pressure to the receptacle, and means for super-heating the air, substantially as described.

6. In apparatus for repairing asphalt pavements, the combination of a receptacle for containing air under pressure, a set of horizontal perforated pipes connected with the receptacle and held in position above the pavement, means for furnishing a supply of air under pressure to the receptacle, means for super-heating the air, and means for confining the super-heated air in position against the pavement, substantially as described.

7. In apparatus for repairing asphalt pavements, the combination of a cylinder for containing air under pressure, a jacket or envelope surrounding the same and leaving an air space between it and the cylinder, fuel burners arranged to enter such space and super-heat the cylinder, and means for projecting the heated air against the pavement, substantially as described.

8. In apparatus for repairing asphalt pavements, the combination of a reservoir for containing liquid hydro-carbons, means for furnishing a supply of air under pressure to the same, a cylinder communicating with the air space of the fuel reservoir, a series of burners connected with the fuel supply and adapted to super-heat the cylinder with its contained air, means for projecting the heated air against the pavement, and means for confining the super-heated air in position against the pavement, substantially as described.

AMOS H. PERKINS.

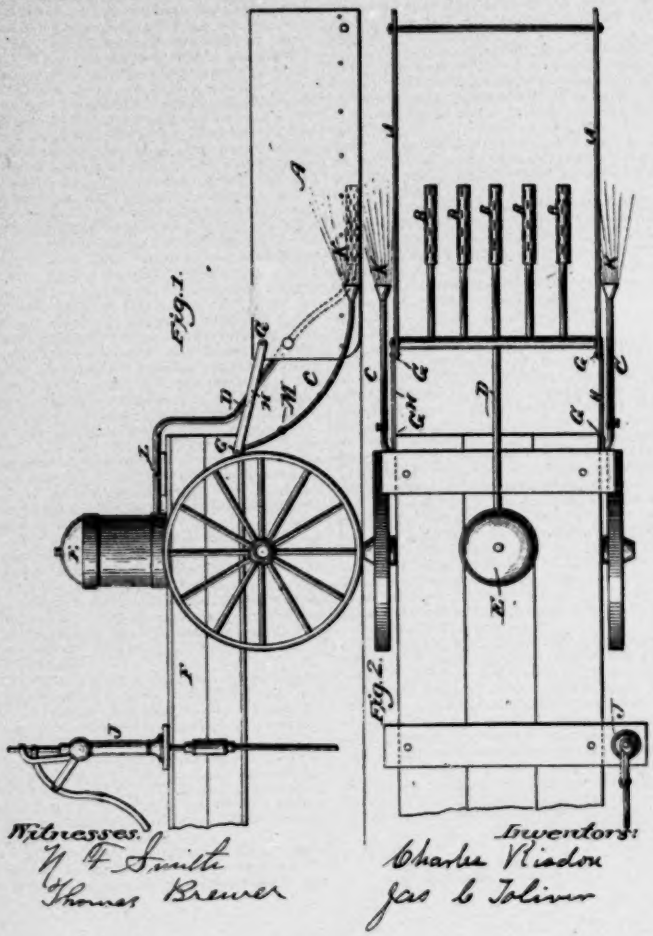
Witnesses:
THOMAS F. SHERIDAN,
JULIUS MOSES.

(No Model.)

C. RISDON & J. C. TOLIVER.

FIRE GUARD AND BACK FIRING MACHINE.

No. 531,648. Patented Jan. 1, 1895.



Witnesses.
W. F. Smith
Thomas Brewer

Inventors:
Charles Risdon
Jas C Toliver

UNITED STATES PATENT OFFICE.

CHARLES RISDON AND JAMES C. TOLIVER, OF AINSWORTH, NEBRASKA.

FIRE-GUARD AND BACK-FIRING MACHINE.

SPECIFICATION forming part of Letters Patent No. 531,648, dated January 1, 1895.

Application filed February 7, 1894. Serial No. 499,885. (No model.)

To all whom it may concern:

Be it known that we, CHARLES RISDON and JAMES C. TOLIVER, citizens of the United States, residing at Ainsworth, in the county of Brown and State of Nebraska, have invented certain new and useful Improvements in Fire-Guards and Back-Firing Machines; and we do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

A movable machine for burning prairie grass within a specified space, consisting of a series of jet burners inclosed at the front and sides by upright metal shields with water sprays running on the outside of the side shields to prevent the spread of the fire; the side shields being placed about four feet apart and dragged parallel with each other over the prairie, the front shield being long enough to fill the space between the side shields in front, the jet burners being placed between them in the front in such a manner as to ignite all the grass and weeds between the two shields, and a spray of water being conducted by means of pipes connected with a water tank and thrown over the grass and weeds on the outside of the shield wetting it in such a manner as to prevent the fire from spreading, thus enabling the burning of fireguards with perfect safety; the front shield being hung on hinges so as to drag immediately in front of the firing apparatus. We attain these objects by the mechanism illustrated in the accompanying drawings, in which—

Figure 1 represents a side view of the machine, attached to a vehicle by means of movable bar H. at G. G. A. represents the upright metal side shield, sharp and cutting at lower edge. B. represents the fire jets supplied with mineral oil from the tank E. by means of the pipe D. K. is a spray of water supplied from tank F. through pipes C. and is thrown over the grass on the outside of shield A. as the machine moves over the surface of the ground. I. is a pump for the purpose of filling tank F. with water. L is a stop cock in pipe D. to prevent the flow of fuel when necessary. M. is a stop cock in the pipe C. to prevent the flow of water when not needed.

Fig. 2 represents a top view of the machine in which K. K. shows the water spraying over the grass on the outside of shields A. A. Either of the shields A. A. can be lifted and either of the water sprays K. K. can be shut off so as to allow the fire to escape and spread to that side if desirable to meet other fires.

What we claim as our invention, and desire to secure by Letters Patent, is—

The combination with fire jets, metal shields to inclose the same, water sprays exterior to the shields, and connections therefrom to the water tank, substantially as described.

In testimony whereof we affix our signatures in presence of two witnesses.

CHARLES RISDON.
JAMES C. TOLIVER.

Witnesses:
J. A. NAY,
B. B. MASTICK.

(No Model.) 2 Sheets—Sheet 1.

A. H. PERKINS.

APPARATUS FOR REPAIRING ASPHALT PAVEMENTS.

No. 542,349. Patented July 9, 1895.

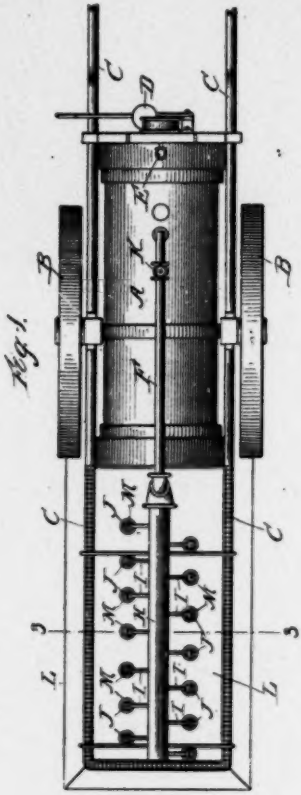


Fig. 1.

Witnesses:
Wm. A. Fleming
V. Hugo.

Inventor
A. H. Perkins
By Raymond & Quackenbush
Attys.

640

(No Model.) 2 Sheets—Sheet 2.

A. H. PERKINS.

APPARATUS FOR REPAIRING ASPHALT PAVEMENTS.

No. 542,349. Patented July 9, 1895.

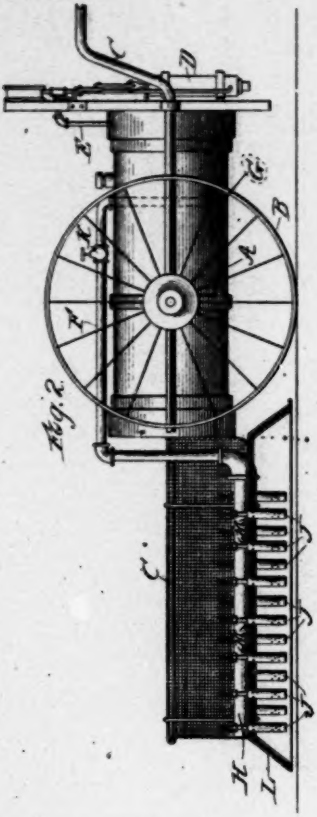


Fig. 2.

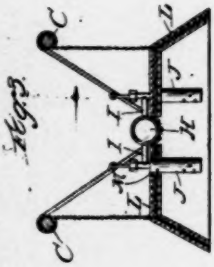


Fig. 3.

Witnesses.
Wm. F. Hamm
V. Hugo

Inventor.
A. H. Perkins
By Raymond & Southmayd Attys.

UNITED STATES PATENT OFFICE.

AMOS H. PERKINS, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE UNITED STATES REPAIR AND GUARANTY COMPANY, OF SAME PLACE.

APPARATUS FOR REPAIRING ASPHALT PAVEMENTS.

SPECIFICATION forming part of Letters Patent No. 542,349, dated July 9, 1895.

Application filed July 30, 1894. Serial No. 519,003. (No model.)

To all whom it may concern:

Be it known that I, AMOS H. PERKINS, a citizen of the United States, residing at Chicago, county of Cook, State of Illinois, have invented certain new and useful Improvements in Apparatus for Repairing Asphalt Pavements, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

This invention relates to improvements in apparatus for repairing asphalt pavements, but is more particularly designed as an improvement upon the invention set forth in Letters Patent of the United States No. 501,536, granted me on the 18th day of July, 1893. In that patent an air-pump attached to the apparatus was used at intervals to maintain a pressure upon the liquid fuel in the tank for forcing the same to the burners, and the burners were shown and described as hooded with a sheet-metal shield to hold and confine the heat to that portion of the pavement against which the burners were directed. Such construction necessitated the occasional and sometimes frequent operation of the air-pump, which necessarily resulted in frequent changes of pressure in the tank and consequent difference in the temperature of the blast of heat, besides which the sheet-metal hood from the excessive temperature to which it was subjected would soon become warped and bent beyond usefulness.

The objects of my invention are to have the apparatus of such character that the heat of the burners may be utilized to produce and maintain pressure in the fuel-tank, whereby a more uniform heat is produced, and to have a hood of novel, cheap, and durable construction, which will not become warped or bent by the action of heat in use. These objects are attained by the devices illustrated in the accompanying drawings, in which—

Figure 1 represents a top or plan view of an apparatus embodying my invention; Fig. 2, a side elevation thereof, and Fig. 3 a detail transverse vertical section on the line 3 3 of Fig. 1.

Similar letters of reference indicate the same parts in the several figures of the drawings.

In the general parts and arrangement of parts of my present apparatus it is substantially the same as that contained in the foregoing patent, consisting generally of a tank A for containing liquid fuel—such as gasoline—mounted upon a pair of ground-wheels B and controlled in its movements by handles C, extending to the rear thereof. On the rear end of the tank is mounted an air-pump D of any suitable construction and mode of operation, connected by a pipe E with the upper portion of the tank for producing the initial pressure upon the fuel contained in the tank. Leading from the tank is a pipe F, which preferably passes through the upper side of the tank and terminates in a suitable nozzle G, near the bottom of the tank, as indicated by the dotted lines in Fig. 2. This pipe leads to the main supply-pipe H, having any desirable number of lateral branch-pipes I, leading to burners J of ordinary construction, the main supply-pipe being arranged in a horizontal position projecting forward from the tank. The pipe F is provided with a suitable valve K to control the passage of the fuel from the tank to the main supply-pipe and burners. Suspended from the handles C or from a separate and suitable framing, and in any suitable manner, is a hood L of oblong or rectangular shape, and preferably having a flat top and flaring sides and ends, which are designed to reach nearly to the surface of the pavement being operated upon, although in practice the exact shape of the hood is not material, as obviously it may be curved or otherwise suitably formed, so as to confine the heat in the immediate neighborhood of the burners. The top of this hood preferably lies in a plane slightly below the center of the main supply-pipe H, and is provided along each side of said pipe with a series of holes M, through which the burners J project, the arrangement being such that the branch pipes I leading to the burners and the valves controlling the same will lie above the top of the hood, protected from the heat of the burners, while the supply of air to the burners is obtained through the openings M, which are of sufficiently greater diameter than the burners to supply the required amount of oxygen thereto. That portion of the hood underlying the main sup-

ply-pipe H is perforated, cut away, or otherwise constructed, so as to expose the end part of the said pipe to the heat under the hood, and this heat converts the liquid fuel in the pipe into a gas, part of which is used by the burners and part of which flows back through the pipe F into the tank, where it creates and maintains the desired pressure in the tank to expel all of the fuel therefrom into the supply-pipe for continuous conversion into gas.

The hood shown in the drawings, and the one I have used in practice, is composed of wire cloth or netting, which is covered, preferably on both sides, with asbestos cement or some other non combustible equivalent material which serves to retain the hood in the desired shape notwithstanding the action of the heat thereon, and also confines the heat, which is thrown down upon the pavement or surface to be heated. That portion of the wire cloth or netting which underlies the supply-pipe H is left without any asbestos cement or other covering, so as to expose the said pipe to the action of the heat from the burners.

While I prefer the construction shown in the drawings, it is obvious that the burners may get their supply of fuel, either liquid or gaseous, through an entirely separate pipe or pipes from that which is exposed to the heat of the burners, and it is equally obvious that the pipe or pipes which are exposed to the heat of the burners so as to produce and maintain gas-pressure in the tank may lie or extend under the hood instead of having the opening in the hood, as shown in the drawings, these changes of construction being so simple and obvious as not to require illustration herein.

A machine constructed in accordance with my present invention possesses the advantage of being self-feeding and utilizing the heat produced thereby for the further purpose of producing and maintaining a pressure upon the fuel in the tank, which will remain practically constant during the use of the machine, giving a steady blast of intense heat and greatly economizing in fuel. Furthermore, a hood of the peculiar construction herein shown will successfully withstand the heat to which it is constantly subjected in use without warping or twisting, and hence avoids the loss of heat which would result from the warping and bending of the hood and also avoids the danger of the burners being extinguished by air-currents, which would pass under a warped hood.

Having described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In an apparatus for repairing asphalt pavements the combination with a series of hooded fluid burners and a reservoir for supplying fuel thereto, said reservoir and burners being portably-mounted, of a supply pipe connecting the reservoir with the burners and exposed to the heat of the burners, substantially as described.

2. In an apparatus for repairing asphalt pavements, the combination with a series of fluid burners and a reservoir for supplying fuel thereto, said reservoir and burners being portably mounted, of a hood for said burners and a supply pipe connecting said burners with the reservoir, lying in a plane with or slightly above the hood, that portion of the hood underlying said pipe being perforated or cut away so as to expose said pipe to the heat of the burners, substantially as described.

3. In an apparatus for repairing asphalt pavements, the combination with a series of fluid burners and a reservoir for supplying fuel thereto, said reservoir and burners being portably mounted of a supply pipe connecting the burners with the reservoir, a hood for said burners lying in a plane with, or slightly below, said pipe, said hood consisting of wire cloth or netting plastered with asbestos cement or equivalent material except that portion underlying the said pipe, substantially as described.

AMOS H. PERKINS.

Witnesses:
W. R. OMOHUNDRO,
V. HUGO.

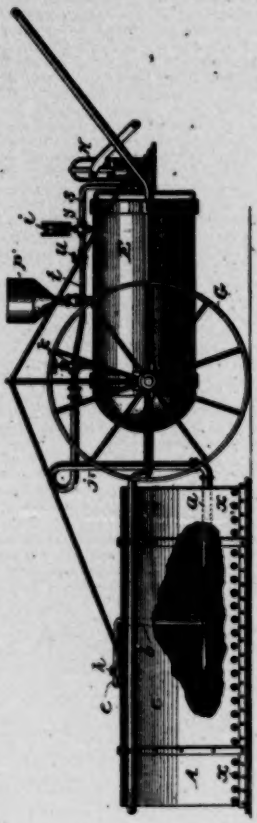
(No Model.) 2 Sheets—Sheet 1.

H. W. LASTER.

METHOD OF AND APPARATUS FOR REPAIRING ASPHALT PAVEMENTS.

No. 552,913. Patented Jan. 14, 1896.

Fig. 1.



Witnesses
Jno. L. Ashkel
J. A. Fangmeier

Inventor
Harry W. Laster
by Foster & Freeman
Attorney

(No Model.) 2 Sheets—Sheet 2.

H. W. LASTER.

METHOD OF AND APPARATUS FOR REPAIRING ASPHALT PAVEMENTS.

No. 552,913. Patented Jan. 14, 1896.

Fig. 2.

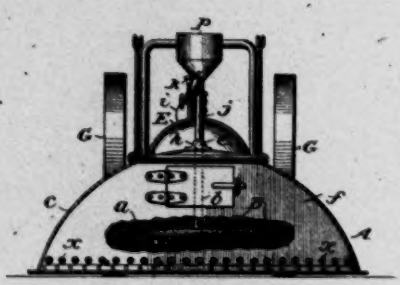


Fig. 3.

Witnesses
Jno. G. Hinkel
L. A. Fairgieve

Inventor
Harry W. Laster
by Foster & Freeman
Attorneys

UNITED STATES PATENT OFFICE.

HARRY W. LASTER, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE BARBER ASPHALT PAVING COMPANY, OF NEW YORK, N. Y.

METHOD OF AND APPARATUS FOR REPAIRING ASPHALT PAVEMENTS.

SPECIFICATION forming part of Letters Patent No. 552,913, dated January 14, 1896.

Application filed June 4, 1895. Serial No. 551,885. (No model.)

To all whom it may concern:

Be it known that I, HARRY W. LASTER, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Methods of and Apparatus for Repairing Asphalt Pavements, of which the following is a specification.

Heretofore in repairing asphalt pavements it has been common to subject the portion to be repaired to blasts of hot air to soften the asphalt or composition, in other instances to effect the same result by the heat obtained from series of burners carried in proximity to the surface, and in other instances the heating is effected by crates of hot coals carried over the surface of the pavement. All these various methods and the use of the apparatus heretofore devised have been attended with more or less expense, inconvenience and difficulties, which it is the object of my invention to remedy. For instance, it is difficult to maintain a uniform and even body of incandescent fuel in an effective condition for any great length of time in a crate. Where burners are used, there are necessarily numerous joints which it has been found impossible to maintain tight, so that the liquid fuel will escape at some points, run onto the pavement and ignite, overheating parts of the apparatus. Further, in cases where liquid fuel is used in connection with a generator for generating gas the construction has been such as to frequently result in the bursting of the generator-pipes. An additional objection to such apparatus as has heretofore been employed with liquid fuel has arisen from the fact that owing to the character of the burners it is necessary to make use of gasoline or other expensive oil. Where the heating has been effected by means of blasts of hot air, it has been difficult to secure the requisite high temperature without an apparatus which is expensive to construct and operate. I obviate these objections, using neither incandescent fuel, air-blasts or vapor-burners, by heating the pavement by means of burning gas and air contained beneath a suitable hood above the surface of the pavement, as fully set forth hereinafter, and as illustrated in the accompanying drawings, in which—

Figure 1 is a side elevation of the apparatus used in connection with my improvement. Fig. 2 is an end elevation. Fig. 3 is a detached perspective view of the generator, burner, and heater-coil.

In carrying out my improved mode of heating I generate a volume of combustible gas and bring the flame resulting from the combustion thereof into intimate contact with a sufficient volume of air, projecting the flame and heated gases toward the pavement and confining the whole volume of gas in a vessel or hood above the pavement until the latter is heated and softened to the desired extent. To this end I arrange a burner and generator B of sufficient capacity within an inverted vessel or hood A, closed except at the bottom and where inlet air-openings *x* are arranged and cause the flame from the burner to be projected into the generator and toward the pavement.

The generator and burner may be of any desired construction; but as shown they consist of a continuous pipe bent into a flat coil *a*—that is, all of the coils are in a horizontal plane—and at the inner coil the pipe is continued upward to constitute a vertical stem *b*, by means of which the coil may be suspended, and is then bent to a horizontal position, plugged at the end, and holes are bored at the under side of the horizontal portion *c* to form a series of perforations to constitute the burner. The said generator is properly supported within a hood or casing A within a short distance of the pavement, the lower edge of the hood almost in contact therewith.

The coils of the generator are highly heated, so that the liquid hydrocarbon admitted to the coils is rapidly vaporized and the vapor freely escapes from the burner and fills the hood with gas, which burns rapidly in combination with the air admitted from below the edges and through the air-openings *x*, the hood retaining the gases in contact with the pavement below, which speedily becomes heated and softened without danger of burning the same or overheating it. The temperature may be maintained constant for any desired length of time, and all danger from leakage is avoided by the use of a continuous unbroken pipe, while it will be evident that the

generator is of such a construction that no fracture or explosion can possibly occur.

While the above-described parts may be constructed in different ways, I prefer the construction which I will now describe, because of its simplicity, cheapness, strength and facility of manipulation.

The hood A consists of a curved sheet of metal *c*, with segmental end pieces *f* riveted thereto to form nearly a semicylinder. The generator B is suspended within the hood, with the exception of the horizontal extension *e*, which lies upon the top of the hood so as to support the remaining portion, and is secured in place by a clip *h*, the hood being perforated below the burner-openings. The frame which supports the hood and tank E is provided with journals which constitute the axles of two wheels G supporting the whole structure.

At the end of the tank E is supported the air-pump H, the delivery-pipes of which communicate at *y* with the interior of the tank and is provided with a gage *i*. The coil *a* communicates with a pipe *j* that is provided with a cock *k* and extends downward into the tank. Between the pipe *j* and the pipe *s* extends a pipe *l*, provided with a cock *u*, so that when desired, by opening the said cock, the air that is in the tank may be discharged into the pipe *j* instead of being discharged into the outer air. The tank is provided with the usual funnel *p* for filling.

One of the advantages of the character of heater which I have described is that it permits the use of crude and less expensive oil than has heretofore been required.

Without limiting myself to the precise construction of apparatus shown, I claim as my invention—

1. The within described improvement in the art of preparing asphalt pavements for re-surfacing the same consisting in maintaining in contact with the part to be repaired, a heated and ignited mixture of gas and air forming a continuous body of flame, substantially as described.

2. An apparatus for heating asphalt pavements for repairs consisting of a closed top and open bottomed hood or casing, a gas generator arranged within the same above the pavement, a vapor burner connected to the generator and arranged at the top of the hood to direct the ignited vapor downward across the generator and maintain the body of flame in contact with the pavement, substantially as described.

3. The combination in an apparatus for heating asphalt pavements of a generator coil consisting of a continuous bent pipe, supported in a substantially horizontal plane, a burner communicating with the coil, with openings arranged to direct the flame across the coil toward the pavement, and a closed-top and open-bottomed hood extending over the coil and burner, substantially as set forth.

4. The combination in an apparatus for repairing asphalt pavements, of a horizontal coil, a burner communicating therewith having openings for directing the flame across the coil and a hood having a closed curved top and segmental end portions, the end of the pipe constituting the burner resting in contact with and connected to the top of the hood, substantially as set forth.

5. An apparatus for heating asphalt pavements for repairs comprising a hood having an open bottom and top which is closed against communication with the exterior atmosphere a frame for supporting the bottom of the hood above the pavement, a vapor burner located at the top of the hood, and a source of fuel supply connected therewith, the openings of said burner being arranged to project the ignited vapor into and beneath the hood and produce a body of flame filling the hood and in contact with the pavement, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

HARRY W. LASTER.

Witnesses:
A. H. CRANEY, Jr.,
JOHN R. COLEMAN.

(No Model.) 2 Sheets—Sheet 1.

A. H. PERKINS.

APPARATUS FOR REPAIRING ASPHALT PAVEMENTS.

No. 560,599. Patented May 19, 1896.

Fig. 1.

Fig. 7.

Witnesses:
Wm. A. Blum
Harry Mudd

Inventor:
Albert H. Perkins
by Raymond & Greenleaf Attys

1215
651

(No Model.) 2 Sheets—Sheet 2.

A. H. PERKINS.

APPARATUS FOR REPAIRING ASPHALT PAVEMENTS.

No. 560,599. Patented May 19, 1896.

Fig. 2.

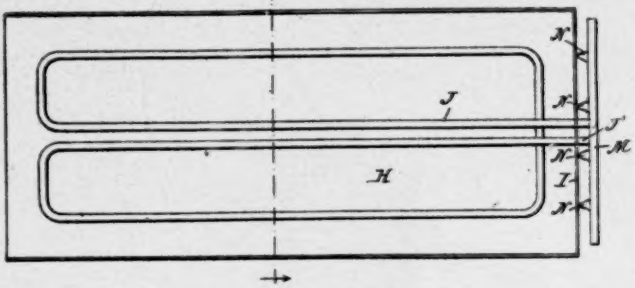


Fig. 3.

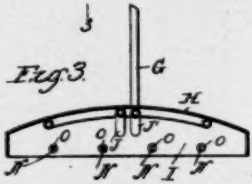


Fig. 4.

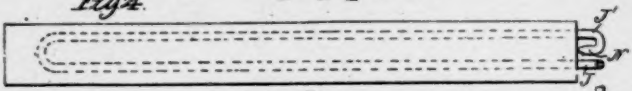


Fig. 5.

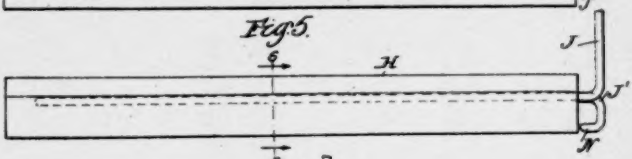
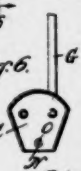


Fig. 6.



Witnesses.
W. M. Rhees.
Harry Whitt.

Inventor
Almon H. Perkins
by Raymond Dickerson Atty's

UNITED STATES PATENT OFFICE.

AMOS H. PERKINS, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE UNITED STATES REPAIR AND GUARANTY COMPANY, OF SAME PLACE.

APPARATUS FOR REPAIRING ASPHALT PAVEMENTS.

SPECIFICATION forming part of Letters Patent No. 560,599, dated May 19, 1896.

Application filed June 15, 1895. Serial No. 552,908. (No model.)

To all whom it may concern:

Be it known that I, AMOS H. PERKINS, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Apparatus for Repairing Asphalt Pavements, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

This invention relates to improvements in apparatus for repairing asphalt pavements, and is more especially designed as an improvement upon inventions set forth in Letters Patent of the United States No. 501,536, granted July 18, 1893, and No. 517,191, granted March 17, 1894. In said patents are shown blasts of flame or superheated air directed vertically upon the pavement and under hoods designed to confine the heat to the part of the pavement intended to be repaired. I have found by practice that while such an apparatus is thoroughly effective in accomplishing the desired result it is open to the objection that the heat, under the influence of the strong blast and winds, will escape around the edges of the hood, and thus soften more of the old pavement than is desired, thereby increasing the labor and cost of repair. This objection is particularly prominent when it is desired to repair narrow cracks in the pavement, and as the hood of these prior machines cannot rest directly upon the ground, so as to confine the heat to the limits thereof without smothering or objectionably reducing the flame-jets, this objection cannot be overcome in the class of machines in which hooded burners are employed. A further and more serious objection, developed by practice, is the burning out of the valves of the numerous burners necessarily employed, which even the shields cannot effectively protect against the intense heat to which they are subjected except for but a short time, and, furthermore, it is necessary with such burners to employ a high grade of gasolene or naphtha. The prime object of this invention is to overcome all of these objections by dispensing with all valved burners and by delivering the heat to the surface to be repaired by horizontal instead of vertical blasts.

Another object is to enable the confinement of the heat to the limits of the hood and thereby avoid the objection incident to the heating of the unworn pavement beyond the limit of the hood.

These and such other objects as may hereinafter appear are attained by the devices illustrated in the accompanying drawings, in which—

Figure 1 represents a side elevation of an apparatus embodying my invention. Fig. 2 represents an inverted plan view of a hood and its connected pipes and burners employed in surface repairing. Fig. 3 represents a transverse vertical section thereof on the line 3 3 of Fig. 2. Fig. 4 is a plan view of a hood and its pipe and burner connections designed for use in repairing cracks. Fig. 5 is a side elevation thereof. Fig. 6 is a transverse vertical section of the same on the line 6 6 of Fig. 5, and Fig. 7 is a detail section illustrating a modification of the burner-nozzle.

Similar letters of reference indicate the same parts in the several figures of the drawings.

Referring by letter to the accompanying drawings, A represents a frame of any suitable construction, terminating in or provided with a handle B and mounted upon ground-wheels C for the purpose of portability. Mounted in this frame in any suitable manner is a tank D, to which is applied an air-pump E and a pressure-gage F. All of the features so far described are common to the patents previously granted to me and do not require any more detailed illustration or description.

Suspended from the frame A upon suitable hangers, such as G, is a hood H, of a substantially inverted-U shape, as more clearly illustrated in Fig. 3, but closed at one end by the end wall or partition I (preferably the end nearer the tank) and open or practically unobstructed at its opposite forward end. Leading from the tank to the hood is a supply-pipe J, preferably having a cock-valve K for entirely shutting off or turning on the supply of fuel, and also a hand-valve L, which is provided as a temporary control for the supply of fuel to the burners during the use of the machine, being readily adjusted by hand

through the medium of a hand-wheel or any other convenient device.

The supply-pipe passes into the hood through the end wall I thereof, as more clearly illustrated in Figs. 2 and 3, and is suitably coiled or bent and disposed under the roof of the hood, to which it is attached by suitable fastening devices, so as to be exposed to the heat under the hood. The end J' of the supply-pipe passes out through the end wall I and has applied thereto a cross or transverse pipe M of a length substantially corresponding with the width of the hood, which cross-pipe is provided with a series of permanently open nozzles N, disposed opposite to perforations O in the end wall I of the hood and preferably as near as practicable to the bottom edge of the hood. These nozzles N may be of any desired character, so long as they are adapted to subserve the purpose of an open burner, and in point of fact it would be only necessary to have short lengths of pipe screwed into the pipe M and flatten the ends of such pipes in order to produce a satisfactory burner. While in practice I have found that the burners disposed, as illustrated in Figs. 1, 2, and 3, entirely outside of the hood and otherwise unprotected are practically satisfactory, in high winds it may prove desirable to have the burners protected by some such caps as that illustrated in Fig. 7, which caps are simply short castings or pipe-sections P screwed onto, or otherwise attached to, the nozzles N and passing through the end wall I of the hood. Outside of the hood the castings are provided with a sufficient number of openings Q to supply the necessary amount of oxygen to the burners.

The hood and its accompanying burners and supply-pipe (illustrated in detail in Figs. 2 and 3) is designed primarily as a "surface" heater for heating surfaces of considerable area where large patches are to be applied to the asphalt pavement; but in Figs. 4, 5, and 6 I have illustrated a narrow-hooded construction, in all general respects like the broader hood, but especially designed for the repairing of cracks or very narrow sinks in the pavement. In this narrow hood but a single burner is necessary, although more may be used; but where a single burner is employed it is either applied directly to the end J' of the supply-pipe, or, as shown in the drawings, the end of the supply-pipe itself constitutes the burner, being flattened or contracted for that purpose and arranged to register with the perforation O in the end wall of the hood, or may be supplied with a protecting-cap, as in Fig. 7. In both of these forms of heaters, which of course may be varied to any desired extent, jets of flame are delivered to the hood at one end thereof and pass along under the hood out of the forward open end thereof, thus serving to heat that portion of the pavement covered by the hood in its passage through the hood. To insure the heating of only so much of the pavement as is covered by the hood the hood may be allowed to rest directly on the pavement, which cannot be done with hoods wherein vertically-disposed blasts are employed, and as the ground, in conjunction with the hood, in point of fact, constitutes a horizontal flue for the heat or flame jets, even though the hood does not snugly fit the surface of the ground, there will be a tendency to draw air in at the side edges of the hood rather than to expel the heat out from under the side edges. I have found by practical demonstration that a space of at least a half-inch may occur between the lower edges of the hood and the pavement without any of the heat escaping therefrom at the sides, and consequently even in the "crack" heater the heat is absolutely confined to the limits of the hood and all objections to the heating of the pavement beyond the hood are eliminated.

The disposition of the supply-pipe under the hood serves to convert the liquid fuel into a gas, which backs up and stores pressure in the tank A, while at the same time supplying gas to the burners, and by employing the horizontally-disposed open burners without valves I am enabled to use with perfect success a very low grade of crude petroleum. This feature is of great importance in the economical use of a heater of this kind, for with the heaters in which valved burners were employed it was necessary to use a grade of gasolene costing from nine to twelve cents per gallon, while I have successfully operated a machine constructed in accordance with my present invention with crude petroleum costing but three cents per gallon. Furthermore, there are no burners to be burned out, with the attendant delay and expense occasioned thereby, and a much more practical and satisfactory result is produced in the use of the machine.

While I prefer to employ the hood open at one end only, when the burners are supplied with the caps illustrated in Fig. 7 the end wall of the hood may be dispensed with and the caps arranged to project sufficiently under the hood to insure the proper direction of the heat, or the nozzles or burners, without caps, may be arranged in proper relation to the open-ended hood to accomplish the desired object. Furthermore, while I prefer to use permanently open valveless burners, so far as relates to the broad idea of my invention the use of valved burners of any desired construction is within the contemplation of my invention, as well as the location of the burners under instead of outside the hood, and various other modifications which will readily suggest themselves to one skilled in the art to which my invention appertains. I have also found in practice that in the use of gasolene and similar light oils the gas generated by the exposed pipes under the hood may be relied upon to maintain the pressure in the tank originally created by the air-pump; but in the use of heavy oils I prefer to rely

upon the artificial pressure obtained by means of the air-pump, and substitute for the cock-valve K a non-return check-valve, which will permit the flow of the oil under pressure from the tank to the burner, but will prevent the return thereof or of the gas generated in the pipes exposed to the heat of the burners.

Having described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In an apparatus for repairing asphalt pavements, the combination with a hood, of one or more burners arranged to discharge horizontally into the hood, said hood being closed at the top, sides and one end thereof, and arranged to confine the heat to the limits of the same, substantially as described.

2. In an apparatus for repairing asphalt pavements, the combination with a hood open at one end thereof, of one or more burners arranged to discharge into the other end of said hood, said hood being arranged to confine the heat to the limits of the same, substantially as described.

3. In an apparatus for repairing asphalt pavements, the combination with a hood, closed at one end and open at the other and provided with one or more perforations in the closed end thereof, of one or more burners arranged to discharge into the hood through said perforations, said hood being arranged to confine the heat to the limits thereof, substantially as described.

4. In an apparatus for repairing asphalt pavements, the combination with a portably-mounted reservoir, a hood, and a supply-pipe leading from said reservoir and disposed underneath the hood, of one or more burners connected with said pipe and arranged to discharge horizontally into the hood, said hood being arranged to confine the heat to the limits thereof, substantially as described.

5. In an apparatus for repairing asphalt pavements, the combination with a portably-mounted reservoir, a hood, closed at its top, sides, and one end thereof, and a supply-pipe leading from said reservoir underneath the hood and terminating at a point beyond one end of the hood, of one or more burners connected with said supply-pipe and arranged to discharge horizontally into the hood, substantially as described.

AMOS H. PERKINS.

Witnesses:
W. R. OMOHUNDRO,
M. E. SHIELDS.

657 At a regular term of the United States Circuit Court of Appeals for the Seventh Circuit begun and held at the United States Court-Rooms in the City of Chicago, in the Seventh Circuit, on the 3 day of October, 1898, of the October term in the year of our third Lord One Thousand eight hundred and ninety-eight, and of our Independence the one hundred and twenty-third year.

And afterwards, to-wit: On the sixth day of September, 1899, in the October term last aforesaid, came the appellee by its counsel, Mr. James H. Peirce, and filed in the office of the clerk of this court his appearance, said appearance being in the words and figures following, to-wit:

IN THE UNITED STATES CIRCUIT COURT OF APPEALS.

For the Seventh Circuit.

No. 633. October Term, 1898

United States Repair & Guaranty Co.,
vs.
Assyrian Asphalt Company.

The clerk will enter my appearance as counsel for the appellee.
JAMES H. PEIRCE.

(Endorsed): Filed Sep. 6, 1899.
EDWARD M. HOLLOWAY,
Clerk.

And afterwards, to-wit: On the sixth day of September, 1899, 658 in the October term last aforesaid, came the Appellant, by its counsel, George P. Fisher, Jr., and filed in the office of the Clerk of this court his appearance, said appearance being in the words and figures following, to-wit:

UNITED STATES CIRCUIT COURT OF APPEALS.

For the Seventh Circuit.

No. 633. October Term, 1898.

United States Repair and Guaranty Co.,
vs.
Assyrian Asphalt Company.

The Clerk will enter my appearance as Counsel for the Appellee.
GEO. P. FISHER, JR.

Endorsed· Filed Sep. 6, 1899.
EDWARD M. HOLLOWAY,
Clerk.

659 And afterwards, to wit: on the seventh day of September, 1899, in the October Term last aforesaid, came the Appellant, by its counsel, Mr. Jas. H. Raymond, and filed in the office of the Clerk of this court his appearance, said appearance being in the words and figures following, to wit:

UNITED STATES CIRCUIT COURT OF APPEALS

For the Seventh Circuit.

No. 633 October Term, 1898.

United States Repair and Guaranty Co.,
vs.
Assyrian Asphalt Company.

The Clerk will enter my appearance as Counsel for the Appellant, the United States Repair and Guaranty Co.

JAMES H. RAYMOND.

Endorsed: Filed Sep. 7, 1899.

EDWARD M. HOLLOWAY,
Clerk.

At a regular term of the United States Circuit Court of Appeals for the Seventh Circuit, begun and held at the United States Court Room, in the City of Chicago in said Seventh Circuit on the third day of October, 1899, of the October Term, in the year of Our Lord one thousand eight hundred and ninety-nine and of our Independence the one hundred and twenty fourth year.

Thursday, October 3, 1899.

Court met pursuant to adjournment.

Present:

Hon. Wm. A. Woods, Circuit Judge, presiding.
Hon. James G. Jenkins, Circuit Judge.
Hon. Romanza Bunn, District Judge.

ORDER.

It is ordered by the court that Romanza Bunn, Judge of the District Court of the United States for the Western District of Wisconsin be designated and assigned to sit in this court as a member thereof during the present session. Thereupon said Bunn appeared and took his seat as a member of said court.

660 And afterwards, to wit: on the third day of October, 1899, in the October Term last aforesaid, came the Appellant, by its counsel, W. R. Omohundro, and filed in the office of the Clerk of this court his appearance, said appearance being in the words and figures following, to-wit:

UNITED STATES CIRCUIT COURT OF APPEALS

For the Seventh Circuit.

No. 633. October Term, 1898.

United States Repair and Guaranty Co.,
vs.
Assyrian Asphalt Company.

The Clerk will enter my appearance as counsel for the Appellant, the United States Repair and Guaranty Company.

W. R. OMOHUNDRO.

Endorsed: Filed Oct. 3, 1899.

EDWARD M. HOLLOWAY,
Clerk.

And afterwards, to-wit: On the fourth day of October, 1899, in the October Term last aforesaid, the following order was entered of record, to-wit:

Wednesday, October 4, 1899.

Court met pursuant to adjournment.

Present:

Hon. William A. Woods, Circuit Judge, presiding.
Hon. James G. Jenkins, Circuit Judge.
Hon. Romanza Bunn, District Judge.
Hon. William H. Seaman, District Judge.

Order.

It is ordered by the court that William H. Seaman, Judge of the District Court of the United States for the Eastern District of Wisconsin be designated and assigned to sit in this court as a member thereof during the present session. Thereupon said Seaman appeared and took his seat as a member of said court.

661 And afterward to-wit: on the twelfth day of October, 1899, in the October Term last aforesaid, there was filed in the office of the Clerk of this court the Appellant's suggestion of a diminution herein and motion for a writ of certiorari, said suggestion and motion being in the following words and figures, to wit:

IN THE UNITED STATES CIRCUIT COURT OF APPEALS.

For the Seventh Circuit.

United States Repair & Guaranty Company, Appellant,
vs.
Assyrian Asphalt Company and James P. Mallette, Appellees.
} No. 633.

And now comes the Appellant, by James H. Raymond and W. R. Omohundro, its solicitors, and suggest a diminution of the record herein in that the transcript of the record in said cause in the United States Circuit Court for the Northern District of Illinois, filed herein, does not embody Complainant's rebuttal evidence, taken in said cause in said Circuit Court, wherefore appellant prays that a writ of certiorari may issue out of this Court directed to the United States Circuit Court for the Northern District of Illinois, directing and commanding said Court to certify and send to this Court forthwith a full and complete transcript of Complainant's rebuttal proofs, on file in the office of the Clerk of said Court in the above entitled cause, No. 24,534, in said Court, and in support of this suggestion and motion appellant presents the affidavit of Otto R. Barnett, hereto attached.

JAMES H. RAYMOND,
WILLIAM R. OMOHUNDRO,
Solicitors for Appellant.

Endorsed: Filed Oct. 12, 1899.

EDWARD M. HOLLOWAY,
Clerk.

And afterwards, on the same day, to-wit: On the twelfth day of October, 1899, in the October Term last aforesaid, the following further proceedings were had and entered of record, to-wit:

662 Thursday, October 12, 1899.

Court met pursuant to adjournment.

Present:

Hon. William A. Woods, Circuit Judge, presiding.
Hon. Romanza Bunn, District Judge.
Hon. William H. Seaman, District Judge.

United States Repair and Guaranty Co.
633 vs.
Assyrian Asphalt Company.

Appeal from the Circuit Court of the United States for the Northern District of Illinois, Northern Division.

On consideration of appellant's suggestion of a diminution of the record herein and motion for a writ of certiorari herein to the United States Circuit Court for the Northern District of Illinois, directing said Court to certify and to file in this Court, a complete transcript of complainant's rebuttal proofs on file in said Circuit Court, and appellant having made a proper showing in support of said suggestion and motion it is now hereby ordered that the said motion be granted and that a writ of certiorari issued forthwith as prayed.

(For return to this writ see page 341 of the printed record in this cause used on hearing in the United States Circuit Court of Appeals for the Seventh Circuit.)

And afterwards, to-wit: On the sixteenth day of October, 1889, in the October Term last aforesaid the following order was entered of record:

Monday, October 16, 1899.

Court met pursuant to adjournment.

Present:

Hon. William A. Wood, Circuit Judge, presiding.
Hon. Romanza Bunn, District Judge.
Hon. William J. Allen, District Judge.

ORDER.

It is ordered by the court that William J. Allen, Judge of the District Court of the United States for the Southern District of Illinois be designated and assigned to sit in this court as a member thereof during the present session. Thereupon said Allen appeared and took his seat as a member of said court.

663 And afterwards, to-wit: On the 17th day of October, 1899, in the October Term last aforesaid, the following further proceedings were had and entered of record.

Tuesday, October 17, 1899.

Court met pursuant to adjournment.

Present:

Hon. William A. Woods, Circuit Judge, presiding.
Hon. Romanza Bunn, District Judge.
Hon. William J. Allen, District Judge.

United States Repair and Guaranty Company
633 vs.
Assyrian Asphalt Co.

Appeal from the Circuit Court of the United States for the Northern District of Illinois, Northern Division.

Upon motion of appellant and it appearing that the record in the above entitled cause was printed in the court below, it is hereby ordered that such printed record may be used in this court if the same conforms, or is made to conform, with the rules of this court.

Tuesday, January 2, 1900.

Court met pursuant to adjournment.

Present:

Hon. William A. Woods, Circuit Judge, presiding.
Hon. James G. Jenkins, Circuit Judge.
Hon. Romanza Bunn, District Judge.

ORDER.

It is ordered by the court that Romanza Bunn, Judge of the District Court of the United States for the Western District of Wisconsin, be designated and assigned to sit in this court as a member thereof during the present session. Thereupon said Bunn appeared and took his seat as a member of the said court.

661 United States Repair and Guaranty Company
633 vs.
Assyrian Asphalt Co.

Appeal from the Circuit Court of the United States for the Northern District of Illinois, Northern Division.

It is ordered by the Court that this cause be, and the same is hereby set down for hearing January 16, 1900.

And afterwards, to-wit: On the sixteenth day of January, 1900, in the October term last aforesaid, the following proceedings were had and entered of record, to-wit:

Tuesday, January 16, 1900.

Court met pursuant to adjournment.

Present;

Hon. William A. Woods, Circuit Judge, presiding.
Hon. James G. Jenkins, Circuit Judge.

Hon. Romanza Bunn, District Judge.

United States Repair and Guaranty Company
vs.
Assyrian Asphalt Company.

Appeal from the Circuit Court of the United States for the Northern District of Illinois, Northern Division.

Upon motion of counsel for appellant, counsel for appellee present and consenting thereto, it is ordered that Exhibits "Perkins' Méthod File," "Malo Pamphlet" drawing marked "Paris, June 21, 1880," and "Defendant's Exhibit Crochet Patent," and the opinion of the Court filed in this cause in the Circuit Court of the United States for the Northern District of Illinois, be filed, and the same is hereby made a part of the record in this cause in this Court.

665 And afterwards, to-wit: On the seventh day of May, 1900, in the October term last aforesaid, came the appellant by its counsel, Mr. James H. Raymond, and filed in the office of the clerk of this court, a certified copy of the opinion filed in this cause in the Circuit Court of the United States for the Northern District of Illinois, said certified copy of opinion being in the words and figures following, to-wit:

IN THE UNITED STATES CIRCUIT COURT,

Northern District of Illinois,

Northern Division.

United States Repair and Guaranty Company
vs.
Assyrian Asphalt Co., et al. } 24534.

OPINION.

KOHLSAAT, J.

This is a suit for the alleged infringement of Letters Patent No. 501,537, for an improvement in the method of repairing asphalt pavements; and of patent No. 560,599, for an improvement in an apparatus for repairing asphalt pavements. Apparatus patent No. 542,349 was also included in the bill, but has been withdrawn.

In the suit of U. S. Repair & Guaranty Co. vs. Standard Asphalt Co., reported in 87 Fed. 339, this method patent was held to have been anticipated by the invention of Paul Crochet, covered by letters patent issued June 10th, 1880, by the French government.

Complainant strongly insists in this suit that the meaning of the term "asphalt" was not properly presented to the court in the Standard Paving Co. case; but while there is considerable more evidence in this suit than in that, covering this question, yet the contention was evidently forcibly argued before Judge Coxe, as he discusses it at some length in his well considered opinion.

Since the argument before me, the opinion of the Court of Appeals of the Second Circuit in the Paving Co. case has been handed me by counsel, and I have considered the same.

From the evidence in this suit regarding the prior state of the art, and the argument before me, I find that the term "asphalt" is not limited in its meaning to the Trinidad deposit, or the so-called Am-

erican mixture," but includes as well the bituminous paving
666 material used in France and elsewhere, comprising natural rock asphalt, and compositions of bitumen and lime or sand particles, and that the claims of the Perkins method patent are so broad with reference to the application of heat to the repair of asphalt pavements that they are anticipated by the Crochet patent, and are invalid.

With reference to apparatus patent No. 560,599; I find it to be a combination embodying improvements upon the original Perkins apparatus, these improvements while not novel in and of themselves (consisting in the use of nozzle instead of burners; the employment of horizontal instead of vertical blasts; and the arrangement of the hood so that it may fit tightly upon the pavement), taken in combination with the best features of the older machines, accomplish a new and useful result, and I hold the entire combination novel and patentable.

In brief of counsel for complainant it is agreed that the bill may be dismissed as to James P. Mallette, against whom no proof has been introduced.

It clearly appears that the device of the defendant company contains the combination of complainant's apparatus patent, and counsel may prepare an order of injunction and reference to take account in usual form.

Northern District of Illinois, } ss
Northern Division. }

I, S. W. Burnham, clerk of the Circuit Court of the United States for said Northern District of Illinois, do hereby certify the above and foregoing to be a true and corrected copy of the opinion of Hon. C. C. Kohlsaat, Judge, filed 27th day of July, A. D. 1899, in the case wherein the United States Repair and Guaranty Company is the complainant and Assyrian Asphalt Company, et al., are the defendants, as the same appears from the original thereof now remaining in my custody and control.

In testimony whereof I have hereunto set my hand and affixed the seal of said court, at my office in Chicago, in said district, this seventh day of May, A. D. 1900.

S. W. BURNHAM,
Clerk.

(Seal.)

Endorsed: Filed May 7, 1900.

EDWARD M. HOLLOWAY,
Clerk.

667 And, to-wit: On the sixteenth day of January, 1900, in the October Term last aforesaid, the following further proceedings were had and entered of record, to-wit:

Tuesday January 16, 1900.

Court met pursuant to adjournment.

Present:

Hon. William A. Woods, Circuit Judge, presiding.
Hon. James G. Jenkins, Circuit Judge.
Hon. Romanzo Bunn, District Judge.

United States Repair and Guaranty Company
633 vs.
Assyrian Asphalt Company.

Appeal from the Circuit Court of the United States for the Northern District of Illinois, Northern Division.

Now this day comes the parties by their counsel and this cause now comes on to be heard on the printed record and the briefs of counsel and on the oral arguments by Mr. James H. Raymond, Counsel for Appellant, and by Mr. James H. Peirce, counsel for Appellee, and the Court having heard the same takes this matter under advisement.

And afterwards, to-wit: On the sixteenth day of April, 1900, in the October term last aforesaid, there was filed in the office of the Clerk of this Court, the opinion of the court in the above entitled cause, said opinion being in the words and figures following ,to-wit:

IN THE UNITED STATES CIRCUIT COURT OF APPEALS.

668 For the Seventh Circuit.

No. 633.—January Session, 1900.

United States Repair and Guaranty Company, Appellant,
vs.
Assyrian Asphalt Company.

Appeal from the Circuit Court of the United States for the Northern District of Illinois, Northern Division.

Before WOODS and JENKINS, *Circuit Judges*, and BUNN, *District Judge*.

The bill charged infringement of three letters patent, Nos. 501,537, 542,349 and 560,959, issued to Amos H. Perkins, the first for a method and the other two for apparatus for repairing asphalt pavement. The second was dismissed out of the case, the last the court adjudged valid and infringed, but declared the method of the first unpatentable because anticipated by the French patent No. 137,208, issued June 11, 1880, to Paul Crochet. The appeal is from this part of the decree. The following are the claims of the method patent infringement of the first only being asserted:

"1. The method of repairing asphalt pavements which consists in subjecting the spot to be repaired to heat, adding new material and smoothing and burnishing it, substantially as described.

"2. The method of repairing asphalt pavements which consists in subjecting the spot to be repaired to heat until the material is softened, agitating it and mixing with it new material and finally smoothing and burnishing it, substantially as described."

The file wrapper shows that the application contained a third claim, reading as follows:

"3. The method of repairing asphalt pavements which consists in subjecting the spot to be repaired to a strong blast of heat, adding new material and smoothing and burnishing it, substantially as described."

The Patent Office taking the position that the first and third claims "are the same in substance, differing only in degree, and both cannot be permitted to remain in the case," the petitioner chose to retain the first.

The specification contains the following statements.

669 "My invention is designed to produce a method whereby the repairing of asphalt pavements may be quickly and cheaply accomplished and a neater appearing pavement be obtained after repairing than has heretofore been the case. . . . Heretofore in the repairing it has been customary to dig out with a pick or other instrument the surface material around the spot to be repaired, sometimes applying heat to the spot to soften the material so that it may be more easily removed. When the material has been removed the depression thus made is thoroughly cleaned and given a coat or dressing of tar. New material in a heated state has then been placed in the depression and been ironed down and smoothed off in the usual manner of finishing, the tar acting as a solder to hold the new material in place. . . . In practicing my invention, however, I subject the spot to be repaired and the surrounding edges to such a degree of heat that the surface asphalt, not only the exact spot to be repaired but the surrounding portion to a greater or less degree, is reduced to the soft, pliable state in which it is originally laid. With a rake or other suitable instrument it is then agitated and mixed with enough new material to fill up the spot to be repaired. It is then subjected to the usual finishing operation of ironing and burnishing. The heating of the surface may be accomplished in various ways and by means of various forms of apparatus and while I have herein shown but one form for accomplishing the result, yet I would have it understood that I do not limit myself to any particular form of apparatus for carrying out my invention."

Then after explaining how by a particular apparatus, of which an illustrative cut is shown, "a strong blast of heat is projected against the surface of the asphalt and readily meets it," the specification proceeds:

"As explained above when it is desired to repair a spot the apparatus is moved adjacent thereto with the burners directly above the spot. These soon reduce the surface asphalt both at the spot and at the surrounding edges to a pliable state, the strong blast causing not only the immediate surface, but the particles deep down, to be melted and yet not burned. With a rake or some other suitable instrument the operator then agitates or stirs up the softened material and by adding new material of substantially the same degree of softness the spot or depression to be repaired is filled up and subjected to the usual smoothing and finishing operation as in the case of a new pavement. This, as will be seen, is done without the use of the tar for the purpose of uniting the parts of sections of material and is done without any distinct dividing line between the old and

new material. In fact there is no dividing line because the new
670 material has been mixed with and becomes a part of the old material. As stated above while heating the spot to be repaired the surrounding edges or portions must be heated to a greater or less degree and the new material is worked into those edges as well as in the spot to be repaired so that when hardened it is practically impossible to tell where the pavement has been repaired."

Concerning the question of infringement the record contains a stipulation that the defendant used an apparatus, resembling that described in the patent of the complainant, under the hood of which the pavement to be repaired was exposed to a blast of flame "until sufficiently softened to the depth of a half-inch or more;" that, the apparatus being then removed, the softened part of the asphalt was thereupon "scraped out with rakes, hoes or suitable tools, to the depth of one-half inch, or more," and thereupon fresh asphalt composition in a heated state was filled into the depression or space so scraped out, and levelled, smoothed and burnished with heated irons and the other usual tools for such purposes.

This patent was held invalid by Judge Coxe in the case of the *United States Repair & Guaranty Co.* v. *Standard Paving Co.*, 87 Fed., 339. After a consideration of the contention of the complainant "that the Crochet patent related to a totally different process" the opinion concludes as follows:

"But assume that the complainants are correct in their construction of the Crochet patent, how then stands the case? Before the Perkins patent it was known that heat could be used to soften a Trinidad asphalt pavement at the spot to be repaired. The Perkins patent so says. It was also known that rock asphalt and bitumen pavements could be mended by heating the top layer, removing the material with a notched hoe, adding new material and tamping it in the ordinary way, so that the part repaired could not be distinguished from the adjacent parts. Did it involve invention to do this to a pavement made of Trinidad asphalt? Would not a mere tyro in paving, with Crochet's furnace, rake and description before him, know enough to practice his method on any pavement of asphalt or equivalent material? If not, then it must follow that should a new variety of asphalt be discovered, or should the constituents of the present surface material be changed the person who is first to use the patented method in connection with the new material can secure a patent even though the patents of Perkins and Crochet on their face cover asphalt pavements of all kinds. In *Manufacturing Co.* v. *Cary*, 147 U. S., 623, 13 Sup. Ct., 472, it was argued that the patent, which covered a process of tempering coiled springs, could be

sustained because the patentee discovered that the application of heat would restore the lost strength and elasticity of the wire; that he was the first to apply heat to springs which had been weakened by use and that his discovery was the new application of an old process and the production of a new resnlt thereby. The Supreme Conrt rejected this argument and voided the patent, observing: "But we are of opinion that the same principle set forth in the patent was developed in the manufacture of the wire bells for clocks and of the hair balance springs: that there was no patentable invention in applying that principle to the springs mentioned in the specification, and that the case is merely one of a double use." See also, *Ansonia Brass & Copper Co.* v. *Electrical Supp'y Co.*, 144 U.S., 11, 12 Sup. Ct., 601; *Phillips* v. *City of Detroit*, 111 U. S., 604,4 Sup. Ct., 580; *Frederick R. Stearn & Co.* v. *Russell*, 29 C. C. A., 121, 81 Fed., 218. The court is convinced, in view of what this record discloses, that it would be inequitable to place the entire art of repairing asphalt pavements by heat under tribute to the Perkins patent in suit. He should be satisfied with the rewards which flow from his contribution to the art which are secured by another patent."

The decree of the Circuit Court was affirmed by the Court of Appeals for the Second Circuit, but on the ground of non infringement. *United States Repair and Guaranty Co.* v. *Standard Paving Co.*, 95 Fed., 137. The Court, recognizing it to be true, as contended, that the application of heat to rock asphalt reduces it to sand or powder, which does not unite firmly with the old material, said: "It is however, noteworthy that Crochet thought that the beneficial effect of his process was to soften the subjacent layer of the French pavement so that it should 'unite perfectly with the new layer, and form with it a thickness, without solution of continuity.' Nevertheless, there is, in fact, a difference in the material of the two pavements, and we are inclined to differ from the Circuit Court, and to regard the Perkins patent as patentable, because it was an application of an old process of intense heating, by means of a movable furnace, to different and dissimilar materials. The two processes were not exactly alike. Crochet treated the surface by vivid heat, removed the damaged part, roughened the remaining surface, and added new material. Perkins heated in the same way, reduced the old material to a soft pliable state, agitated it with a rake, and mixed it with enough new material to fill up the spot to be repaired. . . . The Perkins process places stress upon the perfect commingling of old and new asphalt as a result of the agitation of the particles of old and new material. The defendant's process places no reliance upon this kind of commingling, but scrapes or cleans out the depression, sprinkles a little cement upon the bottom and edges, to be of some benefit

in causing the old and new to adhere, and shovels in and tamps
671 down the new material. Wherein the defendant's process differs from that of Perkins it corresponds with that of Crochet."

The process of the Crochet patent, dated June 11, 1880, the specification describes as follows:

"It consists in reheating the part to be mended by means of a movable furnace which the operator shifts about at the surface of the roadway until such portion decrepitates and becomes friable. The upper part of the layer of asphalt and that which has been damaged are taken off by means of an iron scraper armed with small teeth which perform the office of a rake; said scraper in raising the material forms at the same time upon the part remaining numerous striae which render the surface wrinkled and augment the adherence of the additional over thickness which constitute the recharge."

Crochet's claim is for an invention "presenting as distinctive characteristics the points folllowing: 1st. The softening of the upper surface of the asphalt layer at the part to be repaired, and the removal of such upper surface by means of a toothed scraper which striates the part remaining. 2nd. Re-charging, by the addition upon the surface thus softened of an asphalt layer of convenient thickness, which is stamped by the usual means. 3rd. The movable furnace which I have combined to such end, according to the conditions described and represented."

Mr. Dayton, an expert witness for the appellant, in the course of his original examination testified:

"In this connection it should be stated that while the patent makes no mention of the removal of any of the old material, in practice the surface of the old material, after being melted or softened, is taken off to a little depth, say half an inch to an inch, as found convenient. By doing this, the powdered cement which was applied to the original surface of the pavement when fresh, and any and all impurities and foreign substances which may have been pressed into the surface of the pavement in use, are removed and a fresh surface of asphalt composition is exposed for union with the new similar material added to fill the place level with the general pavement around it. . . . The scraping off of the surface of the old pavement after softening it, to the extent of half an inch or so, is not, in my opinion, a departure from the invention set forth in the patent, and is only what I understood the patentee of complainant's patent promptly commenced to do in the early practice of the method referred to. Moreover, it is, in my judgment, only what a judicious
workman would do in order to get rid of the powdered material
672 and impurities originally placed upon the surface of the pave-

ment or subsequently accumulated therein, so as to give a fresh surface of the old material for contact and union with the fresh new material added. It is only a question of adding so much more of the new material to make up for the old material scraped away. . . . There are three steps or process elements enumerated in this claim, to-wit: First, 'subjecting the spot to be repaired to heat;' second, 'adding new material;' and third, 'smoothing and burnishing' . . . If the removal by defendants of a shallow portion of the surface asphalt . . . be regarded as a difference from the patent, it is, nevertheless, in my judgment, not a departure from the patent, but is merely the addition of a step to the three steps enumerated, and one which, moreover, does not affect the character or result of said three steps further than it is a prudent expedient to make said three steps the more effective. I do not overlook the fact that the specification of the patent 501,537 provides for an additional step, namely, the agitation or stirring up of the softened material of the old pavement preliminary to the addition of the new material. But this is not included in claim 1 here in suit. On the other hand it appears to be expressly excluded from said claim by its specific inclusion in claim 2. . . . X. Q. 51. If the degree of heat were such as to not only melt but also to burn the immediate surface and as well 'the particles deep down,' would such procedure be an infringement of Perkins' method claim 1, assuming that the old layer thus burned were raked away clean before the new filling was supplied? A. I think it would. There must be a melting in advance of the burning, and the removal of the burned part would leave the unburned and melted part in condition for direct union with new material added to fill the place."

On his examination in rebuttal: "The Crochet patent proposes the employment of a fire box having a grate bottom, and containing (we will assume, as most favorable to the patent and device), a body of live coals. At some distance below the grate is supported a sheet metal plate which, in turn, is held a little above the surface of the pavement. The plate is heated by radiation from the coal fire on the grate, and the surface of the pavement is heated by radiation from the plate. The heat which reaches the pavement is, therefore, a secondary radiation from the coals. . . . This is not the mode of operation of the apparatus set forth in the Perkins method patent. This Perkins apparatus employs a flame *blast* sent directly and continuously against the surface of the pavement to be softened. . . . Beneath a thin, stiff crust formed by the Perkins method where the blast flames directly impinge, the asphalt mixture is uniformly softened to any desired depth or shallowness, regulated by the time
673 during which the flame blast is continued thereon. . . . After

the removal of this crust a softened, loosened and rough surface of old material is presented for union with the new. . . . It appears to me that the difference between the Crochet and the Perkins modes of applying heat to the pavement, irrespective of the difference between the pavements themselves, is to be regarded as an essential difference between the two methods of repair, considered as entireties, and that the Crochet patent is not an anticipation of the methods set forth and claimed by Perkins. . . . Notwithstanding this is shown by the record clearly to have been done only upon rock asphalt or "compressed asphalt" pavement, and is not shown to have been done upon American "asphalt mixture" pavements, or by any one indicating a knowledge of the existence of American asphalt mixture pavements, such prior art may possibly be regarded as having a bearing upon the method described and claimed by Perkins. If so, it is still plain that Perkins' method is characterized by a new and useful way of applying the heat to the pavement, to wit, by sending a flame blast into direct contact with the pavement surface. . . . Wherefore, regarding the Perkins method, as distinguished by his different, more expeditious and more effective way of applying heat—to say nothing about any higher degree of heat finally imparted by his method, and nothing about the difference in materal upon which the old and new methods have respectively been practiced—I regard the Perkins method as essentially new and as being unaffected by the disclosures of the prior art in this record. . . . It is a stated object of the Perkins invention that it "is designed to produce a method whereby the repairing of asphalt pavements may be quickly and cheaply accomplished," as well as whereby "a neater appearing pavement (may) be obtained after repairing." There is, in my judgement, no question that, by this Perkins method, repairs may be effected more "quickly and cheaply" than by any method disclosed in the prior art, because of his application of the heat to the pavement by blast flame contact. There is no slow operation by radiation, and there is no delay occasioned by the heating of a plate in a furnace, nor is there any such delay and trouble as must attend the handling of such a plate. Nor is there delay and expense due to the establishment of a thoroughly incandescent coal fire, nor such inequalities of heating at different points as accompany a coal fire resting upon a grate or over a radiating plate, due to the deposit of ash or to unequal incandescence. This feature of Perkins' method is not dependent upon a particular apparatus. The patent so states, and, as a matter of fact, different and improved "forms of apparatus,' affecting the efficiency of the method, have since been devised. These all retain the obviously best idea of using a liquid fluid,

674 but this is not essential to a flame blast and of course not essential to contact of the flame with the pavement surface. Hence, in my judgment, it would not be correct to say that the invention is one of apparatus and not of method. . . . The patent shows and describes only a kind of apparatus which gives a flame blast and directs the flame in to contact with the surface of the pavement. In other words, the Perkins patent and the method therein set forth contain the idea of heating the pavement on the principle of 'transmission,' as distinguished from 'radiation' and 'convection,' the three recognized principles of heat transference. It may be added that the patent is the first disclosure in the art of any apparatus by which heat may practically be imparted to an asphalt pavement on this principle. . . . If the court cannot find in the differen e between the American and French asphalt pavement materials sufficient ground for recognizing patentable novelty in the Perkins invention over the prior foreign art, it seems to me said Perkins' method is amply distinguished from such prior art by its mode of heating the pavement on the principle of transmission by flame contact, without regard to the 'form of apparatus' by which such flame contact may be effected. . . . It is a fact that a thin, continuous crust or scale is formed at the top of the pavement material where the flames impinge thereon. . . . Thescale . . . appears to wholly prevent the burning or impoverishment of the cement beneath it, so that the latter is, in fact, only melted, and is apparently as rich, bright and efficient as ever. . . . In practice this scale or crust is pulled off before adding the new mixture together with some of the melted material beneath it. . . . Undoubtedly the small amount of mixture formed into the crust or scale is impoverished by action of the flames immediately thereon, by which I mean that the bitumen and oil actually reached by the flames are probably burned out. But, by reason of its continuity and density, this scale serves to protect the mixture beneath it in a manner evidently calculated to prevent impoverishment thereof and, on the other hand, to secure a mere melting of such adjacent material, even though the remelting be continued to a considerable depth by prolonged application of the flame to the scale. From one to three minutes is all the time necessary to continue the application of the flame blast heat of the Perkins method to accomplish deep enough melting of the pavement for the purpose of repair."

The following extracts are from the testimony of Charles Elwood Foster, an expert for the appellant, examined in rebuttal:

"I understand from the use of the expression, 'enough new maerial to fill up the spot to be repaired,' that some of the old ma-

675 terial is removed, for otherwise there would be no space to be filled up. The removal of a certain portion of the old material in most cases is necessary because it is not desirable that the spot which is repaired shall be at a higher level than the surrounding portions of the pavement. . . . Reference is also made to filling up the depressions, from which it is evident that the patentee recognizes that a certain portion will be removed to be replaced by the new material . . . While I do not find it specifically stated in claim 1 that the heated part is to be agitated, I do find that claim 1 calls for the heating, that the heating is for the purpose of permitting agitation, and that it calls for adding the new material which can only be effected as described in the specification by first agitating the heated part of the old material. Claim 1 does not call for the mixing of the old and the new material together, but when the old materal is agitated or picked up the addition of new material causes the two to be mixed along the line of union as a necessary sequence to the operations. . . In some instances, as where the foundation sinks below new pavement, it is not necessary to remove any portion of the surface material, the thin layer carbonized or burnt by the actions of the heater being so small in quantity that it may be mixed with the fresh material without detriment. . . . The only effect of the operations specified in the Crochet patent which, to my mind, is attended with any advantage is the disintegration of the pavement by the heat of the tray which is carried over the pavement which facilitates the removal of the portion heated, differing in this respect from the effect of heating a pavement of asphalt mixture, and I recognize that 'by the repeated passage of the movable furnace' referred to in the Crochet patent, the rock asphalt pavement might finally be disintegrated to any desired depth so as to permit the introduction of a very substantial plug of new material. . . Apart from the fact that the patentee Crochet makes no statement as to whether the fresh inaterial is to be hot or cold, I still find that the Crochet patent does not set forth the process of the patent in suit, because it does not describe a process embodying the same operations upon the same material to secure the same result. If I assume that the operations specified in the Crochet patent are the same as those set forth in the patent in suit, their effect on the material is so entirely different in its characteristics that it does not constitute the same mode or process any more than a series of steps upon syrup to clarify it constitutes the same process as the same steps upon coal oil to refine it. . . . It is true that the Crochet patent sets forth that by the application of heat to the surface of a rock asphalt pavement the heated portion of the latter may be disinte-

grated and readily removed, but no one on being made ac
676 quainted with this fact which was known before the date of the Crochet patent would know that it would be practicable to operate upon the surface of a compressed asphalt pavement without disintegrating it but merely so as to melt and soften and reduce it to the pasty condition in which it was laid. . . . Naturally anyone skilled in the art would assume that the application of sufficient heat to secure the softening of the lower body of material would result in practically destroying or burning out so much of the material as would defeat the purpose of the operation. It is only from actual experiment that one learns the fact that upon the application of a blow-pipe as suggested in the patent in suit there at once forms on the extreme upper surface a thin carbonaceous crust which practically protects all of the material below from overheating and reduces it to a pasty or molten condition for a considerable depth. . . . There is no intimation in the French patent of any modification of the process in its application to different purposes, and therefore anyone literally following the said patent upon an asphalt mixture pavement would destructively burn the latter. . . . X-Q. 38. In the practice of the Perkins method should it transpire that some part of the material were burned at the place of treatment, would such burning avoid the Perkins method? A. It would not. Occasionally this would result from the carelessness of the men, but Perkins was, I believe, the first one to disclose the fact that it was possible to direct a strong blast of hot gases onto the surface of an asphalt mixture pavement without materially burning the same or affecting the part below the heated portion. . . . Yes, I do draw a sharp distinction between the 'asphalt mixture' pavements such are used here in the United States and the 'compressed rock asphalt' pavements such as are used in Europe, because I understand that to embody a process there must be substantially the same operations upon the same materials to get practically the same result, and in making a comparison I do not consider the materials to be substantially the same when the effects of the operations are so radically different, as I have pointed out, as they are in treating these two different materials. . . . The claims of the Perkins patent in suit do not require that the old material be either removed or retained. I have before pointed out that in operations under the Perkins process with a new pavement where simply a depression had to be filled up the surface is merely softened so that it could be picked up and opened and the new material added. Generally in repairing old pavements, there is dead matter which must be removed, as I have pointed out, and if the pavement has not sunk, it is necessary to rake out sufficient material to allow for the intro-

duction of the fresh material. As I understand the Perkins 677 patent and claims, the process thereof could be carried out whether or not the old material was removed."

Henry N. Moss, Superintendent of Streets, District of Columbia, a witness for the complainant, testified:

"Under the Perkins heater system the old or poor stuff is burnt out until the burning reaches good material, the depth of this burning under the present specifications was required to be at least three quarters of an inch; I have seen repairs made where the depth was less and the repairs were made in first class order. This burnt out material is then scraped out, and under the present District specification the surface must be reheated again before the asphalt that is used to make the repairs is put in. It is then rolled with a steam roller. . . . R. X. Q. 227. At the bottom of the heated spot what decides the operator as to the amount of old material to be raked off? A His judgment, probably, in other places than Washington. In Washington the specifications require three-quarters of an inch at least."

William H. Lober, the general superintendent of the Vulcanite Paving Company of Philadelphia, "familiar with the methods and apparatus for repairing asphalt pavement" since 1886, testified in behalf of the complainant and on cross-examination answered as follows:

X. Q. 196. "In laying a new asphalt pavement, when the job is left incomplete at night and the men begin their work anew on the day following, what precaution, if any, is observed in effecting a secure joint at the junction between the pavement already laid and the fresh filler just about to be applied next thereto? A. There are several ways of making surface joints. The best joint is made by the Perkins Surface Heater, making a sloping joint; joints are sometimes made by just cutting the edge roughly with an ax, and piling the hot mixture along the edge until it can be softened and broken down, thus making a union of the two parts. Q. This mode of jointing wherein the hot material is piled over the cut edge of the pavement already laid, how long has it been practiced in your knowledge? A. Ever since I have been in the business."

In the Beckwith report to U. S. Commissioners, Paris Exposition, 1867, the manner of resuming and continuing the work of laying asphalt pavement from day to day is thus described:

"To resume the work of the previous day, the edge of the solid asphalt must be cleared of dust and loose particles and a layer of hot asphalt thrown upon it to heat it; when the edge is sufficiently heated the layer thus thrown down is removed and returned to the furnace

for reheating; and as this removal takes place, a hot layer from the carts is thrown down and spread, and the packing immediately
678 commenced as before described. The edges of the old ond new work thus unite perfectly, and no joint seam remains visible."

The final brief for the appellant contains the following:

"If the . . . premise of the opinion of Judge Coxe to the effect that 'any heating device . . . is within the claim' be true, then the . . . conclusions, (1) that this claim places 'the entire art of repairing asphalt pavements by heat under tribute to the patent in suit,' and (2) that this patent is anticipated by the Crochet patent, necessarily follow. But if it appear that this patent, intelligently read, discloses and claims a particular and novel application of (blast) heat (to the proper depth or degree) by a new apparatus which Judge Coxe himself says is 'an ingenious gasoline heater,' then it inexorably follows that the patent should be sustained."

WOODS, *Circuit Judge*, after making the foregoing statement, delivered the opinion of the court:

The contention of the appellant has been narrowed by counsel and by the experts to the assertion that the Perkins "method is characterized by a new and useful way of applying heat to the pavement, to-wit, by sending a flame blast into direct contact with the pavement surface." This, it is insisted, must follow from an intelligent reading of the claim in connection with the specification. The specification, instead of aiding, explicitly and absolutely forbids the proposition. A blast, it is true, is the certain result of the one apparatus which is described as a means of applying the heat, but, unwilling to abide by that, the patentee proceeded to add: "The heating of the surface may be accomplished in various ways and by means of various forms of apparatus, and while I have shown but one form . . . I would have it understood that I do not limit myself to any particular form of apparatus." The reference, of course, is to existing and known "ways" and "forms of apparatus," and not as one of the experts irrelevantly suggested to "different and improved forms of apparatus affecting the efficiency of the method . . . since devised" which "all retain the obviously best idea of using a liquid fluid, . . . not essential to the flame blast and, of course, not essential to the contact of the flame with the pavement." The well chosen words of the first claim are in strict harmony with the unmistakable purpose of the patentee to include in his method all of the "various ways" possible of heating the surface to be effected and the operation of every known form of apparatus capable of being used in any way to the accomplishment of the proposed end. It was then well known "that heat could be used to soften a Trinidad asphalt pavement on the spot to be repaired."

The process of softening the hardened edges of a pavement in course of construction, as the work ceases and is resumed from time
679 to time, was familiar. As a means of bringing heat to bear on a spot of pavement to be softened the apparatus of Crochet was known and that a like device could be used with a measure of success upon the asphalt pavements in common use in this country was established in the case in the Second Circuit, to which reference has been made.

Another objection to the proposed limitation of the claim by making it read "a blast of heat," or "a strong blast of heat," in lieu of the unqualified word "heat," is in the fact that the third claim, which contained the additional words, was withdrawn by the patentee upon a ruling or declaration of the Patent Office that the first and third claims were the same in substance and could not both be permitted to remain in the case. That was not merely a casual expression of opinion by an examiner, but was in effect a requirement that one or the other of the claims be withdrawn, and no reason is perceived for not applying the ordinary rule. Having voluntarily abandoned the claim for a method limited to the use of "a blast of heat," the patentee or his assignee may not now insist that a broad claim, containing no suggestion of such intention, shall nevertheless be subjected by construction to the same restriction. This point, in view of the reservation already considered, is unimportant and might be passed, but it is to be observed that if the third claim was withdrawn by mistake, a correction should have been sought in the Patent Office, either by a surrender and reissue, or possibly by a new application. It is not within the rightful power of the courts to enlarge or restrict the scope of patents which by mistake were issued in terms too narrow or too broad to cover the invention, however manifest the fact and extent of the mistake may be shown to have been.

The problem which Perkins undertook to solve, it seems clear, was one which invoked the powers of invention, but it was much more narrow than it has been treated. It was not to find a method and means of repairing asphalt pavements by "subjecting the spot to be repaired to heat, adding new material and smoothing and burnishing it." It was to find a new and better method and means of accomplishing the one step of heating, and if a patent on the method, as distinguished from the apparatus was to be sought and was allowable, a more appropriate if not the only proper description would have been, not "a method of repairing asphalt pavements," but a method of heating an asphalt pavement for the purpose of repair, or, better than that, for the purpose of softening it at the spot to be dealt with, which of course might be for other purposes than repair, such as

cutting through in order to reach or lay pipes underneath
689 Indeed there seems to have been no reason for restricting eithe
the method or apparatus to use upon any particular pavement
It is capable, evidently, of efficient employment upon all *know*
kinds of asphalt pavement, and upon any accessible surface whic
it may be desirable to heat, but of course with effects varying alway
according to the different qualities of the material operated upon
Treating the invention as being simply for a method of applyin
heat, we incline to the opinion of one of the experts that the metho
itself was separately patentable. Though brought into play by
special apparatus for which Perkins sought and obtained anothe
patent, it seems to be in part the result of elemental and natura
forces, and not merely the functional result of the apparatus, and i
therefore not within the doctrine of *Risdon Locomotive Works* v
Medart, 158 U. S. 68. Once the apparatus was perfected, however
the process followed as a matter of course, and the inventive powe
by which it was evolved is not to be distinguished from that ex
pended in devising the apparatus. The primary conception em
bodied in the apparatus is a blow pipe. Starting with that an
with the fire box of Crochet, with whose patent Perkins seems t
have been familiar, and with a knowledge of the properties of gaso
line or other "liquid fluid" which might be forced by atmospheri
pressure through supply pipes to the burners, the task was not on
for a pioneer. The apparatus of Crochet, as pointed out by Dayton
was defective and objectionable for reasons that are so obvious tha
they must have been anticipated; but the more serious objections
it is evident, could be removed by substituting for the grate botton
and the live coals any form of apparatus capable of producing an
directing a blast of flame against the plate below. Such a flam
thrown uniformly upon the thin sheet metal plate of the device, s
placed and adjusted as to be "a little above the surface of the pave
ment," could hardly be less patent than a direct impingement of th
flame to produce the required effect upon the material to be soft
ened, either for removal or for mixture with added new material
Whether in that way the thin crust could be produced with the direc
contact of flame causes, the evidence does not show, but whether i
could or could not is for the present purpose not important. The
production of the crust is not a part of the process claimed, and i
is conceded, could not be. At most it is an incidental, perhaps in
variable, result of the practice of the process in the one way and by
means of the one form of apparatus described. The testimony is
that only by experiment was that result discovered or discoverable
and it does not appear when the discovery was in fact made
Probably not before the patent was issued, else it would, if possible

have been made the subject or incident of a special claim. But
681 it is unnecessary to go further into details. While it has been determined and stands unquestioned in the case that Perkins invented an improved and much more efficient apparatus for repairing asphalt pavement than any before known, and, incidentally, developed—invented—a new and useful method of applying the heat, yet neither by itself, nor in connection with the other steps mentioned in the claim, is that method covered by the patent.

The claim would seem to be invalid even if it could be said that the word "heat" as used means a blast or strong blast of heat. So read, or read as it stands, is it not for an aggregation of steps which do not constitute a patentable combination? Whether the old material is heated and softened in one method or by one means or another, the addition of new material seems to be a separate and independent act, and equally and more unmistakably so the final act of smoothing and burnishing. If these steps may be regarded as constituting a single process, because the final result is a repaired pavement, then with equal propriety and without constituting an aggregation the preparation of the additional material to be used—all the steps of that preparation and the bringing of it to the place for use, including the means used for bringing it—might be included in the claim.

The decree below is affirmed.

And afterwards, on the same day, to-wit: The sixteenth day of April, 1900, in the October Term last aforesaid, the following further proceedings were had and entered of record, to-wit:

607 Monday, April 16, 1900.

Court met pursuant to adjournment.

Present.

Hon. William A. Woods, Circuit Judge, presiding.
Hon. Peter S. Grosscup, Circuit Judge.

Before:

Hon. William A. Woods, Circuit Judge.
Hon. James G. Jenkins, Circuit Judge.
Hon. Romanza Bunn, District Judge.

United States Repair and Guaranty Company,
vs.
Assyrian Asphalt Co.

Appeal from the Circuit Court of the United States for the Northern District of Illinois, Northern Division.

This case came up to be heard on the transcript of the record from the Circuit Court of the United States for the Northern District of

Illinois, and was argued by counsel, on consideration whereof it is now here ordered, adjudged and decreed by said Court that the decree of the said Circuit Court in this cause be, and the same is hereby affirmed with costs.

682 And afterwards, on the same day, to wit: The sixteenth day of April, 1900, in the October Term last aforesaid, the following further proceedings were had and entered of record, to wit:

Monday, April 16, 1900.

Court met pursuant to adjournment.

Present.

Hon. William A. Woods, Circuit Judge, presiding.
Hon. Peter S. Grosscup, Circuit Judge.

Before:

Hon. William A. Woods, Circuit Judge.
Hon. James G. Jenkins, Circuit Judge.
Hon. Romanza Bunn, District Judge.

683 United States Repair and Guaranty Company, vs. Assyrian Asphalt Co.

Appeal from the Circuit Court of the United States for the Northern District of Illinois, Northern Division.

The cause came on to be heard on the transcript of the record from the Circuit Court of the United States for the Northern District of Illinois and was argued by counsel.

On consideration whereof it is now here ordered, adjudged and decreed by this court that the decree of the said Circuit Court in this cause be, and the same is hereby affirmed with costs.

638 UNITED STATES CIRCUIT COURT OF APPEALS

For the Seventh Circuit.

I, Edward M. Holloway, Clerk of the United States Circuit Court of Appeals for the Seventh Circuit, do hereby certify that the foregoing typewritten and printed pages, numbered from 1 to 30, inclusive, contain a true copy of the record and proceedings in the United States Circuit Court of Appeals for the Seventh Circuit, excepting the return to the writ of certiorari issued pursuant to the order of October 12, 1899, which is found on page 341 of the printed

record used on hearing in this court in the case of United States Repair and Guarantee Company, Appellant, vs. Assyrian Asphalt Company, Appellees, No. 633, October Term, 1899, as the same remains upon the files and records of the United States Circuit Court of Appeals for the Seventh Circuit.

In testimony whereof I hereunto subscribe my name and affix the seal of said United States Circuit Court of Appeals for the Seventh Circuit, at the City of Chicago, this fourth day of May, A. D. 1900.

EDWARD M. HOLLOWAY,

(Seal) Clerk of the United States Circuit Court of Appeals for the Seventh Circuit.

684 United States of America. } ss.

The President of the United States of America, To the Honorable the Judges of the United States Circuit Court of Appeals for the Seventh Circuit, Greeting:

Being informed that there is now pending before you a suit in which United States Repair and Guaranty Company is appellant and Assyrian Asphalt Company is appellee, which suit was removed into the said Circuit Court of Appeals by virtue of an appeal from the Circuit Court of the United States for the Northern District of Illinois, and we, being willing for certain reasons that the said cause and the record and proceedings therein should be certified by the said Circuit Court of Appeals and removed into the Supreme Court of the United States.

686 Do hereby command you that you send without delay to the said Supreme Court, as aforesaid, the record and proceedings in said cause, so that the said Supreme Court may act thereon as of right and according to law ought to be done.

Witness the Honorable Melville W. Fuller, Chief Justice of the United States, the 22nd day of May, in the year of our Lord one thousand eight hundred and ninety.

(Signed) JAMES H. McKENNEY,
Clerk of the Supreme Court of the United States.

687 United States of America, }
Seventh Circuit. }

In obedience to the command of the foregoing writ of certiorari and in pursuance of the stipulation of the parties a full and true copy of which is hereto attached, I do hereby certify and return that the transcript of the record filed with the application to the Supreme Court of the United States for a writ of certiorari in the case of United States Repair & Guaranty Company, Appellant, vs. Assyrian Asphalt Company, Appellee, is a full, true and complete transcript of the record upon which said cause was heard in the United States Circuit Court of Appeals for the Seventh Circuit, together with all proceedings in said court.

In testimony whereof I hereunto subscribe my name and affix the seal of said United States Circuit Court of Appeals for the Seventh Circuit, at the City of Chicago, this 12th day of June, A. D. 1900.

EDWARD M. HOLLOWAY,

(Seal) Clerk of the United States Circuit Court of Appeals for the Seventh Circuit.

IN THE UNITED STATES CIRCUIT COURT OF APPEALS,

688 For the Seventh Judicial Circuit.

United States Repair & Guaranty Company, Appellant,
v.
Assyrian Asphalt Company, Appellee. } No. 643.

STIPULATION.

It is hereby stipulated and agreed by and between the parties hereto, by their respective solicitors that the copy of the record herein heretofore filed in the Supreme Court of the United States, with the petition in said Court for a writ of certiorari directed to the United States Circuit Court of Appeals for the Seventh Circuit, may be taken and used as a full and sufficient return to the writ of certiorari issued out of the Supreme Court of the United States, in the case of United

States Repair & Guaranty Company v. Assyrian Asphalt Company, No. 643, October Term, 1899.

JAMES H. RAYMOND,
W. R. OMOHUNDRO,
Solicitors for Appellant.
PEIRCE & FISHER,
JAMES H. PEIRCE,
Solicitors for Appellee.

Endorsed: Filed June 12, 1900.

EDWARD M. HOLLOWAY,
Clerk.

Oct. Term, 1899. No. 643. Supreme Court of the United States. United States Repair and Guaranty Co., vs. Assyrian Asphalt Co. Return from U. S. C.C. A. of the 7th Circuit to Writ of Certiorari.

File No. 17,757. Supreme Court U. S. October Term, 1900. Term No. 277, United States Repair & Guaranty Co., Petitioner, vs. Assyrian Asphalt Company. Writ of Certiorari and return. Filed June 16, 1900.